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CANADA AND OUR NEW TARIFF.

By Erastus Wiman.

CANADA may always be relied upon to furnish to the United States a series of unsettled problems of prime importance. It is natural that this should be so, inasmuch as the Dominion is a large country, and the nearest to the union of commonwealths that adorn the lesser half of the continent. While two powers possess the continent in common, and the two systems of government are animated by a spirit of reprisal in commercial policy, just so long will there be friction, irritation, and possible belligerency.

The varied nature of the interests affected by this condition, along a border line unparalleled in length, is not greater than the gravity and the far-reaching consequences of the questions constantly at issue. From the war of 1812, so fruitless and expensive, down through all the disputes as to boundaries, even until now when it is unsettled as to which nation possesses the rich mineral regions on the distant Yukon River, there has always been a question as to territorial areas in which the whole country has had an interest. The interpretation of Shore Line treaties, antiquated and inapplicable to the present advanced condition of civilization, has resulted in large payments from the general treasury for fishing privileges, the subsequent surrender of which was followed by the presence of armed cruisers in the Gulf of St. Lawrence, menacing a peaceful pursuit, and by the exaction of a tonnage tax on American fishing craft, even now submitted to temporarily as the price of peace. A constant refusal to permit the shipment of a few quintals of fish by rail in bond mean-

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time is regarded as entirely justifiable by the Canadian government, even in the face of permission by the United States to transport in bond produce and merchandise to and through Canada in proportions so enormous that, should the privilege be abrogated, it would bankrupt the entire Canadian railway system. Equally, the most serious menace which could possibly be maintained against the vast transportation interests in the Northern States and in the trans-continental lines is found in the unbridled competition of Canadian railways, constructed largely on subsidy, and maintained by the constant contribution of English money, and which are without the pale of rigid Inter-State regulation, to which American lines are subjected. So, too, at this late day, a great diplomatic court is convened in a European capital to settle a Canadian question, affecting the Behring Sea, in which the United States and Canada are alone concerned, resulting in a wide discussion of international law by an aggregation of forensic ability rarely gotten together in the history of litigation. So wide is the range of subjects of difference between the two countries, so continuous the dispute, so far-reaching the consequences, that it would seem as if no effort of government of this great country was so important as that which guided its policy towards Canada. Yet it is a fact that on no subject is there among the people at large greater ignorance, and among politicians greater danger of misapprehension.

Aside from the gravity of the questions which unsettle the repose of the two nations, there is always present the shadow of a European complication which inheres in almost every point in relation to Canada. An integral part of the great British Empire, forming as the Dominion does indeed a proportion no less than forty per cent. of the vast area included in the Britisher's boast of a nation upon which the sun never sets, there is always a consciousness of complication in relation to Canadian matters not possessed by other problems. Great Britain is the best customer of the United States, the largest creditor, the warmest friend and most helpful co-partner in the advancement of the highest form of civilization. Anything that would disturb the peaceful relations between these two nations, bound together by ties so intimate and so essential to the existence of each other's prosperity, is to be considered as paramount in importance over everything else. Yet almost every time a Canadian question is evolved it carries with it the possibility of a disturbance between the two English-

speaking nations that dominate the world. This danger is all the greater because of the jealous care with which the possessions of the British Crown are guarded, and more especially by the constant feeling among the thinking people of Great Britain that in no part of the empire is the conflict so prevalent as in Canada between the sentiment of loyalty to British connection, on the one hand, and, on the other, the personal interest of a majority of the population promoted by the closest possible connection between the Canadian and the American peoples. In no part of the empire is the temptation toward secession so great; in no part would secession be so complete and so fatal to the prestige of the empire as in the case of Canada. Measured by the effort which Great Britain put forth in the War of Independence to retain the American colonies, the secession of Canada would be the most stupendous event at present possible to the Mother of Nations. The possibility that republican institutions should suddenly pervade so vast a proportion as forty per cent. of the empire over which the monarchy rules would do more to sap the foundations of that monarchy itself than any other possible event. Such a contingency, following the yielding tendency towards Democracy apparent in recent legislation in Great Britain, would be regarded by many as the first step towards reducing England to the position of a second-rate power, lessening her military and naval force and eventually resulting in a serious set-back to civilization.

It is true these are far-off considerations; yet they are all influential in the relation of Great Britain to her greatest and nearest colony, and incidentally affect the relations of the United States with her greatest and nearest neighbor. So long as the English government, as a first-class military power, controls the destiny of the greater half of the continent, just so long will the Canadian problem possess undue and unusual significance to the United States, rendering it difficult to solve, and perennial in its reproduction in various and novel forms.

There is one question, however, of relationship between the two countries that consideration of England does not affect. That question is the tariff between the two portions of this continent. This subject is one of legislation with the United States and Canada, and is not necessarily affected by diplomacy in which England need take part. Now that it is contemplated by the recent mandate of the American people to revise the mode and extent of taxation, and obliterate the exaction of unnecessary bur-

dens, especially upon the poorer classes, the question of the relation of the tariff to Canada forms a far more vital part of the programme than is generally supposed. If the expressed wish for change in the policy of the American people means anything, it means that there shall be no tax upon raw material, and that burdens on food supplies shall be obliterated. This affects a vast class of the people, and to a degree that nothing else affects them. Inasmuch as Canada can supply the two elements of raw material and food products to an extent greater than any other country, the consideration of the Canadian question in regard to the tariff is of prime importance. It may be doubted whether in the whole range of interests to be considered there is any one section which so affects the sources of supply, on the one hand, the opening of new markets, on the other, and in the end may be so fruitful of future consequences, and so potential in its effect on the continent at large, as the relation of the proposed new American tariff to Canada.

To a very large and intelligent group of thinkers in the country, the existing agricultural schedule of the McKinley tariff, which almost solely applies to Canada, is an instrumentality of great force in helping forward a movement toward a political absorption of the rest of the continent. This group of thinkers have it ingrained in their intelligence that the burdensome exactions of that tariff must, as they say, "bring the Canadian people to their senses," and compel them to realize that their interest entirely rests in the markets of the United States, and with an eventual alliance with the people of this country. Had the McKinley bill been constructed for the purpose of striking the greatest number of the largest class of industrial interests in Canada, it could not have been more skilfully framed. A wider application of disaster, so far as shutting Canadians out of best markets on the continent, could not be conceived in the productions of the soil, the forest, the mines, and the sea. The classes and interests most adversely affected are wide-spread and are resident in all regions, not only comprising the majority of the populace, but affecting practically the financial stability and the debt paying power of the entire community. It will serve a good purpose to illustrate just how far the agricultural schedule of the McKinley tariff has affected the most vital interests by the following table showing the agricultural exports to the United States from Canada in the two years 1890 and 1892 :

Articles.	1890.	1892.	Decrease.
Horses	$1,887,895.00	$1,094,461.00	$ 793,434.00
Horned cattle	104,623.00	21,327.00	83,296.00
Poultry	105,612.00	44,537.00	61,075.00
Eggs	1,793,104.00	494,409.00	1,298,695.00
Wool	235,436.00	200,125.00	35,311.00
Flax	175,563.00	112,360.00	63,203.00
Apples	149,479.00	27,661.00	121,818.00
Barley	4,582,561.00	1,354,485.00	3,228,076.00
Split pease	74,215.00	20,460.00	53,755.00
Hay	922,797.00	598,567.00	324,230.00
Malt	149,310.00	20.00	149,290,00
Potatoes	308,915.00	41,886 00	267,029.00
Vegetables	80,976.00	68,948.00	12,028.00
	$10,570,486.00	$4,079,246.00	$6,491,240.00

A decrease of seventy-five per cent. in the short space of two years in the exports of articles so essential as those above enumerated, in seasons when crops were good and prices fairly high, indicates a deprivation to the people of Canada of very great moment. These figures are significant of the paralysis which has occurred in other departments, as in shipping, transportation, mining, fishing, lumbering, and other great interests, and vividly illustrate the serious consequences of a restrictive policy upon the trade of the two countries.

It is a conviction in the minds of many intelligent people that, with such an object lesson as these figures teach so forcibly, the Canadians will soon sue for admission into the Union. Therefore it is urged that in the new tariff there shall be no change so far as it affects Canada. In the hope of territorial aggrandizement, in the expectation that half a continent will sue for admission into the Union, it is urged that existing exactions on free raw material and cheapened food products shall be continued; in other words, that there shall be no yielding to the demands for a better commercial relation between the two countries which a new tariff ought to bring about, and that, so far as concerns the commercial policy of both countries on this continent, a barrier to trade between them as high as ever shall continue to exist.

It is easy to say that the solution of the Canadian problem lies in the political assimilation of the people of that country into the United States, and in the annexation of its territory in the shape of eleven great States and territories. This is true, and to those who only casually examine the subject and are only partially in-

formed the solution seems quite feasible, quite probable, and altogether desirable, even on terms of the greatest liberality. Yet to those who understand the Canadian people, and are familiar with the political, social, and commercial forces that prevail, both in the colony and in the mother country, annexation seems so far away that its possibility need hardly be considered as affecting the interests of the present generation. It certainly should not at this juncture be allowed to influence the new and enlarged commercial policy of the United States, if that policy has for its purpose the creation of a present trade continental in extent, yielding a present profit equally continental in its contribution.

To show the danger of such a policy, so far as the future trade of half a continent is concerned, and how independent Canada may become of the United States, the following table has been compiled, showing the steady decline in exports to the United States and a corresponding increase in the trade with Great Britain:

	Per cent. exported to United States.	Per cent. exported to Great Britain.		Per cent. exported to United States.	Per cent. exported to Great Britain.
1868.....	60.36	34.31	1889.....	43.58	53.34
1872.....	54.12	40 36	1890.....	36.50	60.08
1878.....	35.78	59.78	1891.....	29.28	66.21
1882	48.11	47.79	1892.....	16.78	77.28
1888.....	44.58	51.95			

The foregoing table indicates that in the last three years, while the McKinley tariff has been in operation, the commerce between Canada and Great Britain has grown with great strides, while that between Canada and the United States has lessened materially. It will be argued that the loss of the Canadian farmer by the decline in trade is the gain of the American farmer in the increased production and the higher price which he has been able to exact. But as against this it can be equally urged that the American consumer (numbering ten to every farmer) has borne the burden of the increased price, while the American farmer has had a competition in the foreign markets which his surplus seeks, which has resulted, with other causes, in such a decline of exports as to seriously threaten the whole commercial fabric of the nation.

In connection with the large proportionate loss of trade from the rest of the continent, indicating its future tendency under equally adverse circumstances, it is important to notice the movement among merchants and others which is now originating in the

United States in the direction of encouraging a political union between the two countries. This movement takes shape in the formation of a Continental Union League of merchants, manufacturers, bankers, and public men in the United States, to the number of 500 already secured, who, it is claimed, will give expression in an organized form to the popular sentiment of welcome with which the admission of Canada would be hailed. Such an organization it is claimed would greatly aid the growth of the annexation desire in the Dominion. This expectation may or may not be true, but it is an open question whether the exercise of outside influences is the policy of wisdom in the question as to the future political destiny of a people so sensitive and so self-reliant as are the people of Canada. Possessed as are the vast majority of them with a reverence for British connection bordering upon veneration; regarding as absolutely treasonable even the discussion of its severance; and realizing, as every one does, that any political change whatever is prompted only by material advantage,—it will be easy to interpret this outside influence, as proposed by the business men and others in the United States, as unnecessary, unwarrantable, and unwise.

This impression certainly will be the one created, should the influence of the proposed League, or the great power of its individual members, be exercised in Washington to keep in force the drastic provisions of the McKinley tariff, so far as it relates to Canada. It is easy to see that if, in view of a reversal of the trade policy which, by the direct vote of the people, the United States determined upon in the recent change of administration, there is a continuance as against Canada of the McKinley tariff, it will be regarded as a special slap in the face. If through the influence of the proposed Continental Union League, made up of the leading business men of the American cities, such a perpetuation of commercial hostility should be permitted, it would be one of the gravest mistakes ever made by an ill-advised body of most intelligent men. The consequence would be a resentment in the minds of the people of Canada against being driven by stress of circumstances into a political alliance which they do not covet, from one in which they are perfectly content, and this, too, by considerations of material advantage, denied to them except at the sacrifice of a sentiment occupying a place in their minds second only to the love of home and all it contains.

It may well be doubted whether any people can be allured

into a political relation by the exercise of commercial hostility, and, if ever Canadians are to be brought into a closer relation with the United States, it cannot be by the principle of repulsion which the McKinley tariff contains. The breaking down of the barrier between the two nations, and the obliteration of the border line so far as trade and commerce is concerned, are much more likely to bring them closer together, and eventually unite them, than to keep up the barbed wire fence which now separates them. A union of interests is much more likely to beget union in sentiment, than a policy of isolation, selfishness, and commercial belligerency.

It would seem as if the commercial policy of the United States towards the rest of the continent might have other immediate purposes in view than territorial aggrandizement. The question of taking in the rest of the continent is one that can very well afford to rest for future decision in the presence of great problems that still confront this country, and it is a mistake akin to a crime that in the faint and distant hope of additional territory there should for a generation, at least, continue to be erected a barrier against expansion of trade in the North, and that there should continue the shutting out of needed supplies from that region.

Of course it will be impossible to have a freedom of trade on this continent, unless both parties agree to that principle. It is not for one moment to be considered that the United States should admit all the products of the northern half of the continent free, and that a high rate of duty should continue in that region against the manufactures of the United States into which these products find their way. The price for the freedom of admission into the United States must be that every article, of every name and nature, should have free admission into Canada.

It is true that the policy of the existing Tory government in Canada is opposed to that principle, and that, by its national policy of protection and the support of manufacturers, it maintains itself in power. But if the American government will offer to the Canadian people a free admission in the new tariff of raw material, natural products, and such slender supplies of manufactures as they can furnish, the return for which shall be the free admission into Canada of all manufactures that the United States can supply, the people of the Dominion will respond gladly in the affirmative to that invitation. During the last summer a convention of the Liberal party, representing the entire Dominion, assembled at Ottawa,

the capital of the country. The party unequivocally committed itself to tariff reform, on the lines so broadly laid down in the recent presidential contest in the United States, and on the platform will appeal to the Canadian electors at the next general election, which will take place within eighteeen months. The party is likely to be successful, and a change in the administration of tne Dominion is therefore imminent. Such a change would be in the highest degree advantageous to the United States. It would be rendered almost certain if the executive of this country, and those who are framing the new tariff, will make it possible that a practical Continental Free Trade shall be established between the two countries. The barriers against the growth of commerce will be broken down, so far as Canada is concerned, and the possible area of the trade of both countries will be at once doubled. A greater step will thus be taken towards the practical assimilation of the people that together possess the continent in common than by any other act now possible. The foundation will thus be laid for the adjustment of all the troublesome problems that arise between the two countries, because in the tariff arrangement between the two nations can be included the settlement not only of interstate transportation questions, and of the Fishery trouble, but of all other topics needing adjustment, and that solely by concurrent legislation, and not by diplomacy in which England is concerned. This would be achieving a continental union, not political in its immediate effect, but commercial and profitable to all concerned. As to its results on the political future of the continent, these can be left to the logic of events.

THE VALUE AND INFLUENCE OF LABOR STATISTICS.

By Carroll D. Wright.

THERE are now in the United States, besides the national Department of Labor, thirty-two State bureaus or departments devoted to the collection of statistics of labor by means of original investigations. Besides, the federal Census Office, the bureaus of statistics of the federal Department of State and the Treasury Department, the State and federal departments of agriculture, and various other offices may be considered as publishing labor statistics in part. But I speak here of the value and influence of those offices first mentioned,—those devoted specifically and technically to the investigation of social and industrial conditions and to the publication of distinctive labor statistics. These offices had their foundation in the establishment of the Massachusetts bureau in 1869. Gradually other States created bureaus of statistics of labor, and in 1884 the United States government added its own office to those already in existence. All the offices, together, have published nearly two hundred octavo volumes, covering a great variety of topics and the results of investigations relative to almost every condition and environment of the working-man.

The character of the work of the different offices varies in some degree, due to a considerable extent to the short tenure of the heads of the different bureaus. Where the governor of a State has allowed himself to ignore politics and insist upon scientific work, the bureaus have achieved the greatest success; but as a rule a governor feels that the office of the chief of the bureau of statistics of labor of his State must be filled by somebody from his party, without reference to the skill, the experience, or the integrity of the incumbent under the previous administration. Yet I am glad to say, as the result of pretty careful study of the reports of all the officials who have done duty in this country during the past twenty-four years, that no matter for what reason they were appointed, no matter how inexperienced in the work of investigation and of compilation and presentation of statistical matter, no matter from what party they came, and whether in

sympathy with capital or with labor, and even if holding fairly radical socialistic views,—the men have, almost without exception, at once comprehended the sacredness of the duty assigned them, and have served the public faithfully and honestly, being content to collect and publish facts without regard to their individual bias or their individual political sentiments. As soon as a man realizes that he is giving to the world a fact, he feels the necessity of accuracy, and that to distort the information collected would be to commit a crime worse than any ordinary lying, because it would mislead legislators and others and fix a falsehood in the history of the State. Many men, too, have come into the work of the statistical bureaus feeling that they could use them as the means of propagandism in some way, and in a few cases this has been attempted, but almost always with failure, because bureaus are looked to to furnish information relative to actual conditions surrounding industry.

That what I have said is true is emphatically illustrated by other countries following the example of the American States. France, Belgium, some of the German States, England, New Zealand, and some of the Scandinavian countries have already established bureaus or departments following in their duties very closely those assigned by law to the American bureaus and departments. A distinguished member of the House of Commons of England told me a few years ago that, whenever he wished to lay any facts relative to working-men before his colleagues, he always had to carry into the House a copy of some American report on the statistics of labor. In the Chamber of Deputies of France, in the German Reichstag, and in the legislative bodies of other countries the American labor reports have been freely used in the economic discussions of the past ten or fifteen years. Had the American offices been failures, these things would not have occurred. It is true, of course, that the sentiment of the times is largely conducive to the successful operations of bureaus of statistics of labor. The general attention paid to social and industrial conditions and all conditions affecting the environment of men has fitted the soil for statistical seed. The altruistic spirit of this age calls for accurate information, that it may know how best to expend its efforts and not dissipate its energy. The question is constantly being asked: "What do social classes owe to each other?" and that any one class may not be deceived in the nature or magnitude of its debt, it must turn to statistics to ascertain the true situation.

The question is often asked, and by very intelligent people, Of what good is a bureau of statistics of labor? Does the workingman secure any direct benefits from its existence? This question cannot be answered very specifically, any more than could one asking for the direct benefits of the public school. It would be a difficult process to show how a dollar more is made to enter the pockets of the working people through the existence of the public schools, or any other educational institution, and yet all men will admit that the sum of benefits is largely increased by the existence of schools. Personally, I have always contended that the bureau of statistics of labor, wherever it exists, is simply a part of the educational machinery established by the community through which it is enabled to know more of itself. "Know thyself" is an injunction which should be applied to communities as well as to individuals, and it is only through rigid, impartial, and fearless investigations that any community can know itself in many directions. Notwithstanding this general view of the educational influence of the offices I am considering, very many instances of their specific influence can be cited. These instances I must, for purposes of convenience, draw largely from those which have come under my own observation or within my knowledge, for to enter upon a research of all the influences which have come in direct ways from the services of all the offices in existence in this country would take me too far afield.

One of the first results that I remember, as being traceable to a published report, related to the tenement-house system of the city of Boston. In the second, third, and fourth reports of the Massachusetts Bureau of Statistics of Labor there were many facts showing the condition of the tenement-houses in the city named. The public was fully apprised of the misery that existed in them, resulting from bad conditions, ill construction, and all that tended to make tenement-house life an evil. Public attention was aroused through these publications, better laws were framed and passed, and a public sentiment created which crystallized in a reform movement having for its purpose the improvement of tenement-houses in Boston. Some of the worst places were improved, and the impetus then given is still active, as is shown by the existence of societies in that city and their influence in securing from the legislature two years ago an appropriation to enable the bureau in that State to make a very exhaustive investigation covering every tenement of whatever grade in the city of Boston.

The bureaus everywhere, wherever conditions warranted it, have investigated the subject of child labor and shown to the public all the facts connected with such employment, the evils it entailed upon the community, and the methods which could be resorted to for its reduction, and everywhere, too, the results have been beneficial. If the bureaus had never accomplished anything else than the marked reduction in the number of young children—those under ten years of age—who are employed in factories and workshops, they would have amply repaid the public for its expenditure in their equipment and support.

The publication of information relative to the inspection of factories and workshops in England and other countries, together with statistics showing the necessity for such inspection in this country, has led in several States to the establishment of boards of factory inspectors. These boards have committed to them the execution of all laws providing in any way for the benefit of those who have to work in any kind of productive establishments. These inspectors enforce the laws concerning the hours of labor, the employment of women and children, the guarding of machinery so that the operatives may be more free from accidents, and in all ways undertake the enforcement of all laws of the character specified. Through these efforts (and they were largely induced by the reports of labor statistics) child labor has decreased, accidents have been reduced in number and severity, the hours of labor have been shortened and the necessity of the reduction recognized, and so all along that line of facts the influence of the reports of the offices we are considering has been enormous; the value of their statistics cannot be expressed by figures.

The first ten-hour law in this country was passed by the Massachusetts legislature in 1874. The statistics published by the bureau of that State helped the passage of the law in a marked degree, and they saved it from repeal in later years. The manufacturers, finding that they were brought under the ten-hour law so far as minors and women were concerned, felt that the manufacturers in surrounding States ought to be brought under like laws or else the law of Massachusetts should be repealed, for they claimed, as the claim was made in England years ago, that in working under a ten-hour law the manufacturers of Massachusetts were placed at a decided disadvantage relative to the manufacturers in the surrounding States; so the legislature directed the Bureau of Statistics of Labor to investigate the subject of the

hours of labor in that State and in the other New England States. The result of the investigation showed that, working under a ten-hour system, the Massachusetts manufacturers paid more wages than those in the other States, where eleven and twelve hours were the rule; that they produced more goods on any basis that could be named, whether individually or per machine; and that in every respect the Massachusetts operatives were under better conditions than those of the surrounding States. There has been no attempt since that report was published to repeal the ten-hour law of Massachusetts. On the other hand, other States have followed suit, until now that system prevails almost generally in the United States.

The bureaus have been very influential in securing a modification of the old common-law rule relating to the liability of employers for accidents occurring to their employés. Under this rule a workman cannot recover damages for injuries received through the carelessness or negligence of a co-employé, although a stranger might recover damages for an injury following the same carelessness or negligence; as, for instance, under the old common-law rule, a brakeman on a train running perhaps 500 miles could secure no damages from a railroad corporation in consequence of injuries received through the carelessness or negligence of a switchman along any part of the line, although the brakeman knew nothing of the switchman, had no knowledge of his skill or capacity when he engaged with the company, and in no sense of the word, so far as reason is concerned, could be considered the co-employé of the switchman; yet, as that common-law rule grew up before great industrial enterprises were established, judges had projected it and had ruled that in such a case as that just mentioned the switchman and the brakeman were co-employés, and therefore the employer could not be held liable. The agitation for a legislative change in this common law rule in England resulted in the enactment of a law in 1880 changing or modifying the rule, and, in this country, the matter being taken up by bureaus of statistics of labor, several legislatures have been convinced of the justice of a change, and have therefore made it; the dire results which were predicted as sure to follow the change of the rule have not followed. In this direction the bureaus have done a great service, not only to the employés of railroads and corporations engaged in productive industry, but in securing the public against the employment of incompetent men.

Another very emphatic influence which the bureaus have exercised is in the abolishment or modification of what is known as the "truck-store" system, or, as it is more popularly known in some parts of the country, the "pluck-me" method of store-trading. This system consists in the establishment of a store by the proprietors of a works for the supply of its employés. Formerly the prices charged at these stores were much higher than those charged at other places, and so the employé of a concern having a truck-store was almost compelled, and in many instances actually compelled, to purchase the necessaries of life for his family at an exorbitant price, whereby the employer made a second profit on the labor of the employé. In very many instances the workmen of such an establishment never saw any money from one year's end to another. The pay for the goods purchased in the store was secured by the pay-rolls, and the debts and credits left no margin on pay-day. Early in the existence of bureaus of statistics of labor this system was attacked through the statistical method, and the result has been that in very many States laws have been passed making it a criminal offence, in some cases, to carry on such a system, and in other cases making it the duty of the proper officers to see to it that they are regulated. The evils of the truck store system have not yet been entirely eradicated in this country, but the change during the last fifteen years has been great, and the value to the wage-receiver of the greatest importance.

In this connection I might mention the influence which the bureaus have had in securing more frequent payments for the working-man. Formerly the payments were monthly. Under this system the credit system grew also, because without ready money the wage receiver must secure credit of his grocer, and the grocer, under such circumstances, looks out that the charges are sufficient to cover the delay in receiving his money or the losses which may come through his endeavors later on to collect the amount of his bill of the employer through the trustee or the garnishee system. Weekly payments have been shown by various bureaus to be beneficial in eradicating some of the evils of the credit system.

In some of the western States there have grown up during the past few years some of the most rascally practices on the credulity of the working-man that have ever been known. They are robberies of the meanest sort, for they not only rob a man of his money, but in many instances of his manhood. The practice I refer to is that of a certain class of employment-offices, located

usually in the rear of some beer-saloon, which advertise that a large number of men are wanted for labor in a certain city, but almost always at a distance. In a western city one of these offices advertised for one thousand men to proceed immediately to Washington, D. C., where employment would be furnished at $1 per day. Hundreds of men responded to this advertisement. They were obliged to pay down $3 or $4, as the case might be or as the rascality of the manager might demand, and then the men were put off by various excuses for several days, until they began to clamor for their contract. When they became too demonstrative, the manager would pay back a part of the sum advanced, for the sake of integrity. Meantime, however, these hundreds of men, loafing about his beer-saloon, had expended more or less money for beer, in addition to the fee paid for the supposed employment. In one city an advertisement appeared for a large number of men to be shipped to Iowa, while in Iowa an advertisement appeared for a large number of men to be shipped to the very place of the first call. The bureaus in some of the States where such practices have been carried on have collected the information relative to these offices, and have exposed the swindle perpetrated upon the wage receiver. Much good is being derived from these reports, and it is confidently expected that, in addition to the laws already passed, others of a more stringent nature will follow and the evil practice be eradicated.

These instances of the direct influence and value of bureaus of statistics of labor are sufficient, it seems to me, to prove beyond any question their right to exist, their right to the sympathy and support of the public, and their right to ample equipment and means for carrying on their beneficent work. But they have another office to perform, which is one of the leading offices of statistics in every direction, and that is the correction of false impressions and the removal of apprehension, and two or three instances of this kind may perhaps be of service.

The statement is usually made by writers on the labor question from the capitalistic point of view that the prosperity of the savings-banks of the country represents absolutely the prosperity of the working-man,—that the total amount of savings in such banks clearly indicates the prosperity of labor. I am not disposed to question this statement, so far as it applies as a principle, but I question the degree of accuracy contained in it, for the investigations of the Massachusetts bureau have clearly shown that only

about one-half of the deposits in the savings-banks of that State, in which the savings-bank institution has flourished for many years, and prospered, too, belong to men and women engaged in manual labor or in the toil necessary to the production of goods. Such a fact, properly brought out, simply sets people's thoughts in the right direction, although it does not disprove the sentiment underlying the erroneous statements regarding the conditions involved.

In 1878 a great deal was said about the unemployed in this country. It was reported, and the report was very industriously circulated, that there were from 200,000 to 300,000 people out of employment in Massachusetts, 40,000 in the city of Boston alone, and 3,000,000 in the United States. These figures were quoted in newspapers, works on political economy, speeches in Congress, political resolutions, etc., until they came to be believed everywhere, and yet no attempt was made, officially or otherwise, to ascertain the real facts. The Bureau of Statistics of Labor of Massachusetts undertook to make an investigation of the subject, and this it did at two separate canvasses, one in June, 1878, and the other in November of the same year. The result showed that in that commonwealth, on June 1, there were 28,508 skilled and unskilled laborers, male and female, out of employment, seeking and in want of work, and that in November there were not more than 23,000 of the same class. On these bases, there could not have been over 460,000 unemployed able-bodied men and women in the United States, ordinarily having work, out of employment at the time mentioned. The report further showed that in the commonwealth mentioned there were in 1875 only 316,459 persons engaged in manufactures and mechanical industries, in occupations upon which they depended for support, whether actually employed or not, and the whole number actually employed in the manufacturing and mechanical pursuits of the State was 308,963. If, therefore, there had been 200,000 or 300,000 persons out of employment in the State in June, 1878, as the alarmists were in the habit of stating, there could have been hardly any left in the factories and work-shops of the community. The figures published by the report were used all over the country, and completely reversed the popular belief relative to the vast number of the alleged unemployed in the country.

But I think one of the most striking instances of the removal of false impressions from the public mind relates to mortgage indebtedness on real estate. In a speech made in Congress in May

1888, the statement was quoted from an agricultural paper that the estimated mortgage indebtedness of all real estate in Ohio at that time was $701,000,000; in Indiana, $398,000,000; in Illinois, $620,000,000; in Wisconsin, $250,000,000; in Michigan, $350,000,000; in Iowa, $351,000,000; and statements were made for other States. The Ohio and Michigan Bureaus of Statistics of Labor undertook to investigate this subject, through the offices of the registers of deeds, the boards of assessors, etc., and in these two States the mortgage indebtedness, as established and estimated by the Commissioners of Labor, was, for Ohio, $330,999,205, and for Michigan, $129,229,553, instead of the amounts popularly claimed. Under the federal census of 1890 an investigation has been made relative to mortgage indebtedness, and the facts established with remarkable accuracy for the other States just named. By the investigation of the census it is shown that in Indiana the mortgage indebtedness is $110,730,643; in Illinois, $384,299,150; in Wisconsin, $121,838,168; and in Iowa, $199,774,171. It is a little remarkable that the sums accepted in a popular way for the mortgage indebtedness of the States named were in some instances exactly the valuation of all the property of the State. The extravagant figures quoted were used all over this country and in Europe, wherever capitalists were seeking investments in this country. The figures did immense harm; the wrong cannot be calculated; but as time goes on the statistics emanating from bureaus of statistics of labor and from the Census Office are removing the apprehension which grew out of the original statements.

Another feature relative to mortgages relates to the causes for which mortgages are placed upon farms in the western country. It has been claimed in recent years that the great mortgage indebtedness of western States is due largely to disaster or adversity. The Commissioner of Labor of Nebraska undertook to satisfy himself, by positive investigation, as to the truth or falsity of such claims, and he took as the territory for his investigation the county of Sarpy, covering the period from December 31, 1879, to January 1, 1890. Sarpy is one of the oldest counties in Nebraska, and it therefore offered the best opportunities for investigation in that State. The result, as to the causes for the creation of the mortgage indebtedness of the county, is shown in the following statement, taken from Commissioner Jenkins's report for 1889–90:

Purchase money	58.	per cent.
Permanent improvements	3.	per cent.

Purchase of stock	4.	per cent.
To meet personal obligations	.5	per cent.
To invest in real estate	7.	per cent.
To invest in mercantile business	20.	per cent.
Sickness	.25	per cent.
Unknown causes	7.25.	per cent.

Allowing that all the mortgages from sickness and from unknown causes were the result of misfortune or of adversity of some kind, the foregoing table shows that 92½ per cent. were for legitimate causes, and such causes as indicated prosperity rather than adversity.

The investigation under the eleventh United States census comprehends the object of indebtedness for 102 selected counties in several States, the results being obtained by personal inquiry through the experts of the office. That investigation is a clear and emphatic corroboration of the results arrived at by Commissioner Jenkins of Nebraska. It shows that to legitimate objects, indicating clearly prosperity and advancement, 94.37 per cent. of all the mortgage indebtedness of the 102 counties considered must be attributed.

These few instances show the enormous value of statistics in removing apprehension and in correcting erroneous views. The money value of such information is too great for ordinary calculation.

Notwithstanding all that I have said relative to the value and influence of the statistics of labor, I am perfectly well aware that they could be made of far greater value; but that greater value can only be secured through the direct action of the legislative bodies behind the bureaus. They are very poorly equipped. They need more men and more money. They need experience, which can only come through the influence of the executives of the States. With an enlarged tenure of office and an increase in the equipment and means of the bureaus, their future usefulness can be made to far excel that of the past and of the present. The lines of work which they can undertake are numerous and inexhaustible. Knowledge of production is absolutely essential for the adjustment of many of the difficult questions we are facing to-day, and any contribution, through statistical investigation or otherwise, that will enable both the capitalist and his employé to more clearly understand the real conditions of production should be welcomed by all elements of the community. The bureaus must be kept in the future, as in the past, free from partisanship. The statistician is not a statistician when he is an advocate, no matter how skillful he may

be in the manipulation of figures. He must be impartial, he must make his investigations without any reference to theories to be proved or disproved, and give to the world the actual results of his inquiries. This country lacks trained statisticians. We have no means for training them, except in the practical work of the statistical offices of the State and federal governments. These offices, therefore, become a school for the future, and the statisticians of this country that are to be of great service to the governments must acquire their knowledge through the statistical offices; but no work can be accomplished successfully without money and without men. We must look, therefore, to the legislative branches of our various governments for the increase of the usefulness and for recognized influence of our bureaus of statistics of labor.

THE WIDENING USE OF COMPRESSED AIR.

By Whitfield Price Pressinger.

ALTHOUGH considerable attention has been devoted of late in the technical press to compressed air and improved types of air-compressing machinery, few have paused to consider the multiplicity of duties to which this power is applied, and the variety of work in the successful performance of which it is an important factor. This development is interesting in a general point of view as a feature of modern progress, and the control of this air, which the child uses to actuate his pop-gun and the aborigine in Thibet employs to produce light, is fast becoming a power in the commercial world.

Compressed air, utilized for power purposes, either locally or at a distance, has been known to the world for nearly two hundred years, Dr. Peppin, an eminent French engineer, having conducted some experiments with it in the early part of the eighteenth century. It has been more or less identified with almost every prominent engineering work in America in modern times, furnishing as it does a means of transmitting power a long distance from its source, without the heavy losses from condensation attendant upon the use of steam ; or supplying the power for sinking a bridge caisson without interfering with the duties of the workmen inside ; or permitting mines to be worked at levels where the use of steam would be impracticable, the exhaust air having a marked effect upon the temperature of the mine. But the employment of compressed air for sinking bridge caissons, operating rock-drills, coal-cutters, and other mining machinery, manipulating air-brakes, tunnel-driving by the pneumatic process, etc., are familiar ones and passing mention of them will suffice in a summary of the various uses which have been devised for this power and the service it is performing for the engineer, scientist, and manufacturer.

The pneumatic dynamite gun is a familiar example of the duty which is made possible by air under pressure. The pent-up energy which, when released under a pressure of 2000 to 3000 pounds per square inch, hurls a projectile containing 500 pounds of nitro-gelatine and dynamite through a mile of space in eighteen seconds, with an initial velocity of 800 feet per second, is a powerful factor in the art of war.

Another employment of comparatively recent development,—but designed for the preservation, not the destruction, of life and property,—is the pneumatic device for block-signaling. In this duty the compressed air is supplied from a central station and each semaphore or signal-arm is operated by a separate cylinder and gear fitted to the signal-post, the valves of the apparatus being controlled by electricity. In some instances the air is carried in two-inch pipes to a distance of nearly eight miles from the point of supply, the pipes on the main road being supported on stakes along the track. When it is necessary to pass through yards the pipes are carried underneath the ballast of the road. The air-pressure maintained is about sixty pounds per square inch.

The method of raising water from deep wells by means of compressed air is one that has recently commanded attention, and many of our largest factories and mills have discarded deep-well pumps and become dependent upon their air-compressors for their entire water-supply. Indeed, so successful has been the work done by this system of raising water that one manufacturer whose neighbor had introduced it found his entire water-supply diverted and was compelled to adopt the compressed-air method or close his works. The plan is that of the siphon and consists of little else than two plain parallel iron pipes inserted into the well, one acting as an inlet for the compressed air and the other serving as an outlet for the water, which is expelled in a solid column. The pressure of air used is of course directly proportionate to the depth of the well. Results differ as to the exact saving in power and repairs in comparing this method with the best deep-well pump practice, but in an individual instance a daily water-supply of 300 gallons was secured against a former possible supply of 75 gallons. The average efficiency of the deep-well pump is 30 per cent., whereas as high as 70 per cent. is claimed for the compressed-air method.

The utilization of crude petroleum for fuel purposes affords another example in which compressed-air is highly necessary. The air is used at a pressure of ten to fifteen pounds per square inch, and sprays the oil into a jet at the point of consumption. This system is utilized in about fifty different varieties of work, such as iron- and steel-forging; tempering, welding, annealing, making tin-plate; for furnaces, glory holes, lears, and ovens; in glass- and pottery-works; japanning, and heating retorts in gas-works. In all of these plants the air-compressor is a very important adjunct, for without it they cannot be operated.

The chemical manufacturer finds compressed air a valuable servant in emptying tank-cars containing acids, and forcing their contents to various parts of his works. He also employs compressed air to agitate and cool his solutions. The sugar interest is also a large user of compressed air for agitating and cooling syrups.

In india-rubber factories the hose is removed from the iron mandrels by forcing a current of air under fifty to sixty pounds pressure between hose and mandrels, thereby inflating the hose, and permitting it to be easily slipped off. The hose-manufacturer also uses compressed air for testing his product, a test as high as 1000 pounds pressure per square inch being demanded on some varieties. A new plan which has lately been adopted in silk-mills is the spraying of solutions on silk ribbon by means of compressed air under forty pounds pressure. This system is highly successful, as it possesses many advantages over old methods and is rapidly being introduced by the manufacturers.

Pneumatic riveting-machines are to-day used in all construction works of any size, this being another form of operating with compressed air, where the exhausting steam would render the use of the latter impossible. In the same manner compressed air is used in boiler-shops for operating tapping- and calking-tools and portable drills. It is being widely introduced into monument and architectural stone-works for operating pneumatic carving-tools, the latter being immeasurably superior to hand tools, both in the saving of time and in execution.

Pneumatic cranes and hoisting-machinery open a very large field of usefulness for compressed air, for establishments are found in every branch of trade equipped with apparatus of this description. As an instance I would mention the Armour abattoir, in Kansas City, which conveys animals through all the various stages of slaughtering, cleansing, dressing, etc., entirely by this method; and many other industries employ it to a like extent. The piston-and- cylinder hoist, with its various modifications, is used.

The numerous systems of pneumatic tubes for transmitting mail matter and other parcels by air pressure have been too thoroughly described to require more than mere mention, but the plant installed in the Philadelphia Post-office is only an entering wedge to what, it is believed, will eventually be adoption by the government. In this service we are far behind our foreign cousins, who have had numbers of such plants in operation in London, Paris, Berlin,

and other cities for years, there being about fifty miles of such tubes in Great Britain alone.

Among the oldest forms of employment of compressed air, are those to be found in refrigerating and ventilating. Ammonia has supplanted air for the former duty, but the various new systems and improvements of old systems of ventilating recently introduced bid fair to solve the problems which have so long vexed ventilating engineers and incidentally to bring compressed air into further prominence as a servant and benefactor of mankind.

The propulsion of cars by compressed air is another source of utilization of this power which has received the attention of engineers for some years past. The Mekarski system, which has been operated so successfully in Paris and other European cities, has been introduced into this country, and the Judson, Kames, and other systems are more or less known. A compressed-air motor needs no conduits or overhead contrivances, does not emit smoke or hot gases, and is almost noiseless. It is very light and can easily be handled on the steepest grades. It is simple in form and does not frighten horses, the machinery in front being almost invisible from outside. With the increasing efficiency of the best types of air-compressors, and the resultant economy in compressed-air production, the cost of this system is gradually approaching the most favorable comparison with other methods of street-car propulsion.

A recent application of an old principle is a pneumatic culm-conveyor, designed to remove culm from the coal-breaker and convey it to any desired point by directing a current of compressed air into the receiving pipe. If the air be heated it performs the further duty of separating the dust from the small pieces of coal. Pneumatic grain-elevators, operating on a similar plan, have been used to a considerable extent in England, and to a less degree in this country. A plant of this kind at Birmingham has tubes of various dimensions, and a capacity of twenty-five to sixty tons per hour. The chief feature consists of the peculiar-shaped nozzles through which the grain is drawn and forced upward at an enormous rate. Operating under forty pounds pressure the grain is raised to a bin at a height of forty feet, descending thence into a weighing device. The cost of unloading grain cargoes by this method approximates four to six cents per ton.

The system for the disposal of sewage by air under pressure has palpable advantages under certain conditions. In the plant at

the World's Fair, with which many of my readers are no doubt familiar, the territory is divided into sections, each having its own ejectors, into which it drains. These ejectors operate alternately, the pressure being turned on and off by automatic valves and the contents forced to their destination through cast-iron mains.

Another utilization of compressed air at the World's Fair was that of painting the large buildings by means of a spray, the air forcing the paint through a hose to a nozzle which is handled by the painter instead of his brush; playing away at the object to be painted much after the manner of the gardener on the lawn. In the dome of the Horticultural building the painter stood about seventy feet above his source of supply, and a large amount of space was covered in an incredibly short time by this method.

The Australian sheep-shearing machine is another mechanical device operated by compressed air. It is claimed for this machine that a hundred sheep can be sheared in the time formerly required for seventy, that the value of the wool is enhanced by its use, and that the animal is never mutilated. It operates at forty pounds air-pressure, and makes 6000 revolutions per minute, the exhaust air preventing the generation of undue heat.

An application of another old idea depending upon compressed air for its success has recently been attempted,—that of raising sunken vessels by placing collapsible india-rubber bags in the hold of the vessel and connecting these bags by means of hose to an air-compressor located upon a tug at the surface. When the bags are inflated to a pressure of sixty to eighty pounds per square inch it is claimed that enough water is expelled from the hull of the ship to restore very nearly its original buoyancy. The schooner *Glenola*, sunk off the Long Island coast, was recently raised by this method. It has been proposed to adapt this same principle to all new vessels by dividing each ship into air-tight compartments, with doors properly packed, each compartment being supplied by a tube from an air-compressor. With a suitable system of switches the water could be ejected from any compartment, should a leak become manifest on an electrical indicator in the switch-room.

In the purification of a city's water-supply compressed air is used largely. A plant was installed by Professor Leeds at Hoboken, in 1884, the air being used at 128 pounds pressure. Since that time companies (now merged into one) controlling the various existing methods of purification have established plants in many cities and towns in the United States.

A large number of experiments with compressed air are continually being tried. Among the uses which have never been reduced to the practicability of commercial requirements, I am reminded of an experiment which was tried some years ago, before the small steam racing crafts of to-day were contemplated. A steamer was seen one day to pass through the Kill von Kull at the then extraordinary speed of twenty-five miles per hour. This was accomplished by means of two air-compressors pumping air beneath her hull, thereby imparting great buoyancy. Unfortunately the swell from her rapidly-revolving paddles was so great as to wash over piers and wreck small boats, and it was even alleged that it injured oyster-beds in the vicinity. A drag was adopted to keep down the swell, but the expense of operating in this manner was too great, and the project was abandoned.

In addition to the various applications of compressed air already enumerated, it is employed to operate the steering-gear of vessels, to supply divers in submarine operations, to mold patterns in foundries, and a western railroad is reported to clean the seats of its passenger-cars with jets of compressed air. Physicians use air largely for treating patients by means of a spray, and hospitals are equipped with chambers in which the patient breathes air pumped in at a pressure of thirty to forty pounds per square inch In some of our large buildings any depreciation of pressure on the hydraulic-elevator tanks is replaced by means of compressed air.

In fact, there seems to be no limit to the employment of this power, and inventions in the success of which it is an important factor, and new methods of performing old tasks which it renders possible, are continually being introduced. And with the recent improvements in the direction of increasing the economy and efficiency of the prominent types of air-compressing machinery, and the further advantages realized from developing increased power by re-heating the air, many foresee the era when a central plant will be established and a compressed-air main will be situated under every street, operating mills and factories as in Paris and Birmingham; ventilating buildings in summer and warming them in winter; preserving perishable merchandise in cold storage; operating elevators, grinders, pumps, saws, printing-presses, lathes, and the countless other machinery of commerce. Others even go further and look for its introduction into houses, the same as gas and water, for ventilating, for warming in winter and cooling in

summer, and for operating lifts, sewing- and washing-machines, and even clocks.

In compressed-air we have a power ever ready to do our bidding, summoned or dismissed by the simple turning of a valve. It operates in place of steam without the least change of plant, obviating the employment of engineers and firemen, doing away with boilers and their accompanying disadvantages of waste steam, smoke, ashes, dirt, dust, risk of explosion, disagreeable odors, the expense of cartage, increased rates of fire insurance, water tax, etc. The old maxim that "importance oft attaches to trifles light as air" becomes doubly true when we consider that this atmosphere, always so necessary to human existence, is being concentrated and harnessed to the service of mankind in so many new and widely-different ways.

THE IRON-ORE REGION OF LAKE SUPERIOR.—I.

By Richard A. Parker, C. E.

THE iron-ore fields of the Lake Superior region, in the United States, are so extensive in area and so rich in their deposits, as to have become a factor of the greatest importance in the iron-making industry of the whole world. In treating of them at considerable length in these pages, therefore, it is not as if a local interest were being described, but rather one in which every great nation has an interest. The iron zone extends from the meridian passing through Chicago westward to the Pokegama Falls of the Mississippi river, a distance of about two hundred and fifty miles. The ore-bearing rock-series traverse the western half of the Upper Peninsula of Michigan, the eastern half of Wisconsin, and extend about eighty miles in Minnesota.

There are five iron-ore "ranges," one of which (the Marquette) lies wholly within the boundaries of the Upper Peninsula. Two (the Menominee and the Gogebic) are partly in Michigan and partly in Wisconsin, while the other two (the Vermilion and the Mesaba) lie wholly in Minnesota. The order in which the ranges are named corresponds to the order of their discovery.

THE MARQUETTE RANGE.

The history of the first find of iron ore in the Lake Superior region is fraught with much interest; and, as is usual in such cases, some question exists as to whom the honor of priority of discovery belongs. The earliest authentic knowledge of its existence is doubtless recorded in the papers of Mr. W. A. Burt, a surveyor, who in 1844 was engaged in establishing township lines and making geologic notes. On September 19, 1844, while running the east line of township 47 north, range 27 west, in Michigan, he observed by means of the solar compass "remarkable variations in the magnetic needle, amounting to 87 degrees from the normal."

On the other hand it is claimed that iron ore was known to exist, as far back as 1830, to the white traders who, in their search for furs for the American Fur Company, traveled over the hills and mountains, and doubtless did see the outcropping masses of ore glistening in the sunlight. The Indians doubtless also were aware

of its existence, but not of its value or the means whereby it could be made serviceable to them.

In 1845 a half-breed, Achille Cadotte, was told by an old Indian chief, Mar-di-me-sik, then living at the mouth of Carp river near the site of the present city of Marquette, that he knew of a mountain of iron and went with him to see it. Cadotte afterwards informed Mr. P. M. Everett, of Jackson, Mich. (one of the incorporators of the Jackson Company, which was organized to operate in the copper district), who made an effort to locate the ore, but failed. Upon Mr. Everett's return to the mouth of Carp river he fell in with the Indian chief, who piloted the party to the Jackson mountain and also to what is now known as the Cleveland mine. Some 300 pounds of this iron ore was "packed" down to the Lake and carried to Detroit and Jackson, as specimens. Some also was sent to Pittsburg to be tested, but it was pronounced worthless. This was probably because more or less of the jasper in which the ore occurs was associated with it, as other portions from the same lot yielded a small bloom, which Mr. Everett had made into a knife-blade.

In the fall of 1846 the Jackson Company began mining development, and in the summer of the same year commenced the erection of a forge upon the Carp river, about three miles east of Negaunee. The forge was operated upon Jackson ore, but ran only a few days after being started, as a freshet washed the dam away. It was started again in the fall and ran successfully for a short time, making four blooms daily from two fires; each bloom was about four feet long and eight inches thick. The forge was kept in operation until 1854, when it was abandoned. Another forge was built at Marquette just south of the shore end of the merchandise pier in 1849, under the direction of A. R. Harlow, Esq. It was destroyed by fire the following winter and never rebuilt. Two other forges were subsequently built at Forestville and Collinsville. Though these furnaces were supplied with ore from the Jackson mine, but little progress was made in mining until after the completion of the company's dock in 1855; regular shipments, however, did not begin until the spring of 1856. The vessels in those days carried from 150 to 500 tons of ore, which was loaded into the holds by men wheeling the ore in barrows. The ore was carried by wagon from the mines to the dock over a plank road, which subsequently was converted into a tramroad, on which mules were the motive power. This road was used until 1857,

when the first railroad for hauling iron-ore in this district was built.

The changes that thirty-five years of progress have wrought are little short of the marvellous: the plank road has given way to a finely equipped railroad, which hurries its load of 600 tons over docks into pockets which empty into the holds of vessels capable of carrying 3000 tons; mines, whose output then would be reckoned at a few thousand tons a year now are capable of shipping hundreds of thousands of tons each season; mines that yielded their ores at the surface and at times above the general surface level now are 600 to 1000 feet deep. Hoisting by a horse-whim has given place to elaborate hoisting-engines capable of exerting 1000 horse-power each. Little was then known in this district of the art of mining, as, at the time of the first discovery of ore, it is estimated, there were not over 50 white inhabitants within the present limits of Marquette county. To-day no country can show better methods or more efficient labor than is found in the Lake Superior district. The original methods were largely derived from English practice, but they have been modified to suit special cases and exigencies, each mine having its peculiarities in the disposition of the ore-body in the ground, character of the inclosing walls, or nature of the ore; all these are more or less variant in each property, and the economical and safe extraction of the ore is the problem to be solved by the local management. How this is done in some of the more prominent mines will be outlined.

All the ore beds, deposits, or lenses occur within the limits of what has been known as the Huronian series of rocks, by which term was included all rocks lying between the Laurentian below it and the Cambrian, or earliest fossiliferous rocks, above. Quite recently however, at a conference of the members of the U. S. Geological Survey, it was decided, owing to the impracticability of the certain correlation with one another of the one or more pre-Cambrian series which occur in the various regions, and since a uniform plan for mapping must be adopted, that a term of the same class as Cambrian, Silurian, and Devonian should be selected for rocks here included, and to occupy this place the term Algonkian was proposed and accepted; the Leewenawan and Huronian series together, therefore, now constitute the Algonkian which has heretofore been known as the Huronian.

On the Marquette range the Huronian rocks are divided into the upper and lower, in both of which bodies of iron-ore are found;

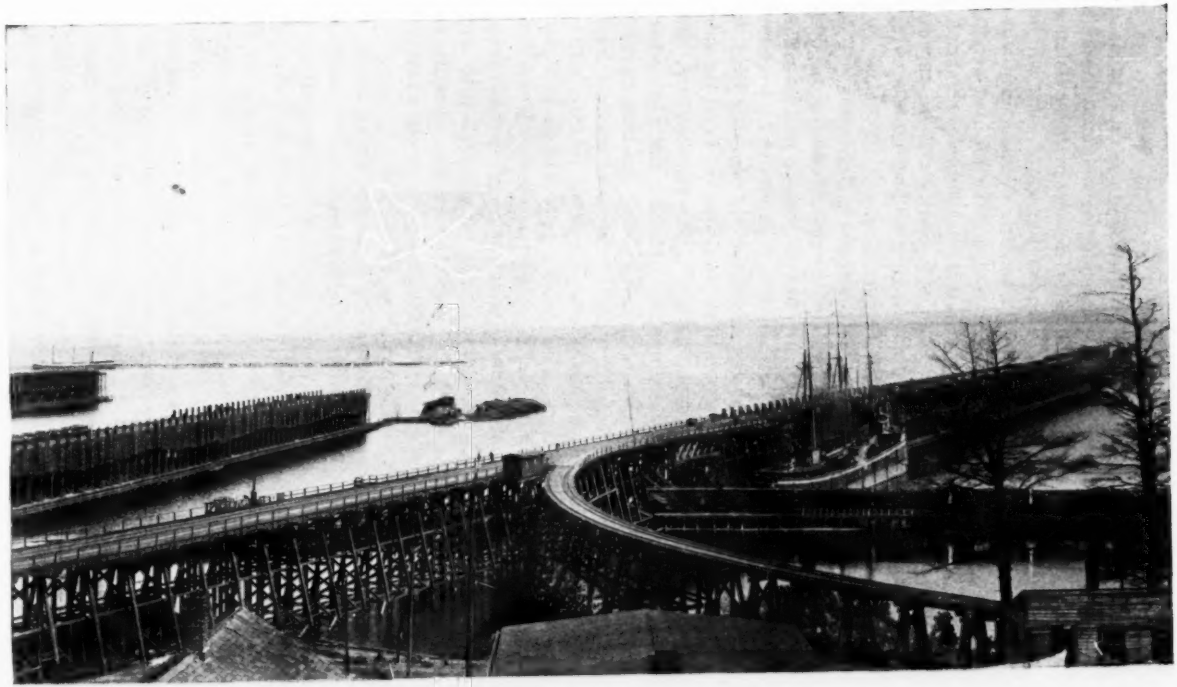
roughly speaking, the western half of the range belongs to the lower and the eastern half to the upper Huronian, while the ore beds and deposits of the Menominee, Gogebic, and Mesaba may be placed in the same division. The strategraphy of the Vermilion range corresponds closely with that of the western portion of the Marquette range. The deposits in and around Negaunee and Ishpening, which towns are respectively 12 and 15 miles west of Marquette, are usually found lying in a U-shaped basin of greenstone, with a marked pitch to the west. At others the ore is encased in a matrix of jasper, while at others slates form the foot or wall upon which the ore-body rests.

In plan the deposits are irregular and vary very greatly in width, ranging from a few feet to over 300 feet wide. Some of them outcrop at the surface, while others have to be prospected for underground either by means of cross-cuts in barren rock, drifts following small "feeders," or by diamond drilling either above or below ground. In the mines having lenticular masses, such as the hard specular or magnetic ore of the Champion, Republic, Michigamme, or Humboldt mines, the use underground of the diamond drill has been of untold value and importance, as by it the lenses which are separated often by many feet of tough, barren jasper are located definitely and access to them obtained in the shortest distance possible. As lenses do not usually have the same maximum width that is found in deposits of ore of a softer nature, it is necessary that the adjacent rocks must be thoroughly explored, so that they be not left in the ground ; if, however, lenses do not achieve greatness by their width, they do in the depths they attain. But what has been said is not intended to convey the idea that the deposits, *per se*, are shallow ; on the contrary, many of them reach to depths that challenge the deep-rooted lenses of hard ore.

None of the developed ranges have yielded the same amount or variety of iron-ore as that obtained from the Marquette range. Beginning its shipments early in 1856, in spite of depressions, panics, and the successive opening of other ranges, it has maintained a growth that is surprising even to those familiar with its history ; while the State of Michigan, which in reality should read Upper Peninsula of Michigan, as no iron ore of any moment is produced elsewhere in the State, stands first in the list of producers in the United States, as it has done for a great many years. The total iron ore mined in the State during 1892 was 7,543,544 long (2240 lbs.) tons or 46.29 per cent. of the grand total for the

United States, showing an increase of 1,416,543 long tons, or 23.12 per cent. over the 1891 product of 6,127,001 long tons of the State. Of the total for the State 7,228,406 long tons or 95.82 per cent. was red hematite, giving Michigan first rank as a producer of this class of ore, with 62.06 per cent. of the nation's red hematite total. The increase in the quantity of ore of this character over the 1891 output (5,445,371 long tons) was 1,783,035 long tons, or 32.74 per cent. The remainder of the output, consisting of brown hematite (187,306 long tons) and magnetite (127,832 long tons), showed a falling off from the 1891 output in these grades. This decline is doubtless due to the favor with which furnace men look upon the softer ores, which, it is claimed, require less fuel for their reduction in the blast furnace, and to the fact also that the harder ores require crushing before being charged; as this was an added expense, the softer ore had the advantage of this cost of crushing over the harder ore. At the mines where this latter grade of ore is produced, notably at the Champion mine, Michigan, and Minnesota Iron Company's properties in Minnesota, enormous crushers have been introduced, so that in the future the furnace will receive ore free from the objection of size and consequent difficulty of one handling, and an ore that contains practically no moisture.

The iron ores found in commercial amounts upon the Marquette range consist of limonite, magnetite, and the several varieties of red hematite; this last is an ore in which the iron occurs as an anhydrous oxid, giving a red streak upon a porcelain plate, the color being generally brownish red, or red, blue, purplish, and dark gray to black. This class includes "red hematite," "specular" (from its glistening scales which become detached easily from the ore mass), "micaceous," "slate" as well as "martite" (which is a pseudomorph after magnetite,—that is, it has the granular or crystalline appearance of magnetite, with the chemical composition of a hematite: it yields a red streak upon porcelain). Hematites shipped to lower lake ports vary in their iron contents from 58 to 68 per cent., when the sample is dried at 212° Fahr. At times these ores, owing to their plastic condition, absorb and retain considerable mine water, from 5 per cent. to as high as 17 per cent. When in transit from the mine to the docks, or when the ore is allowed to stand in the railroad yards, it is subject to the vagaries of the weather; a sharp shower of rain will add an appreciable amount to the weight of a car of ore; while, if the ore is allowed to remain in cars or the pockets of the dock during a warm spell, the loss

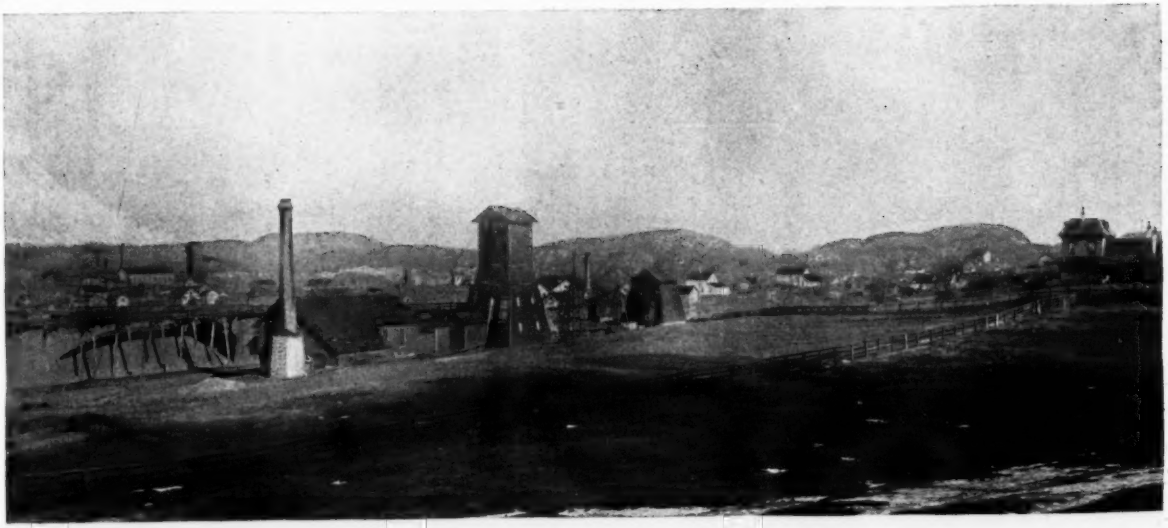


DOCKS AT MARQUETTE, MICHIGAN—LOOKING EAST.

of water by evaporation is considerable—enough at times to make a very serious discrepancy between the shipping weight at the mine and that at the receiving port. These differences largely balance each other however, so that at the end of the season there will be but a slight adjustment of the totals needed. Vessels upon leaving port have one per cent. deducted from the railroad weight, which is the bill of lading weight ; this is intended to cover shrinkage by desiccation, or loss by handling. Such a method appears crude and hardly in keeping with the care and scientific working given to other departments of mine operating.

The amount of magnetite mined is annually decreasing. This falling off is due almost entirely to the cost of mining the ore, the ore itself being hard and dense, usually incased in a matrix of jasper which is tough and hard, making it expensive to drive the needed gangways, or sink shafts. Still, the high furnace yield of this ore and crushing to convenient size will always permit the sale of its fair proportion. Years ago it was the standard ore, and prices of all others were based upon it. The magnetite ore, when pure, contains 72.4 per cent. of metallic iron ; the balance, 17.6 per cent., being the combined oxygen. Cargoes of this ore have been shipped which would analyze 69.0 per cent. in iron, with 3 per cent. of silica and carrying less than .03 per cent. of phosphorus. The Republic, Champion, Michigamme, Baron Humboldt, and Edwards (now Samson) are the mines that have been the more prominent producers of this grade of ore. Associated with and at times merging into magnetite is found the specular hematite, in these mines. In the Republican and Champion mines about an equal amount of each kind of ore is raised.

Of limonite ore there has in the past year or two been but little mined. It contains more water than a hematite, and therefore carries a lower percentage of iron, rarely if ever exceeding 60 per cent. Owing to its low metallic contents, but little is shipped to lower lake ports, as the freight paid would be largely for an abnormal amount of water ; for this reason, and the fact of its reducibility in the stack of a furnace, it is in demand by local furnaces. It is yellow to brown in color, soft, and often it is a self-fluxing ore ; that is, it contains the correct proportion of iron, lime, and silica to smelt and free the iron from the accompanying impurities ; being porous, the heat and reducing gases readily penetrate and reduce the ore to a metallic state. It is a low grade ore, and not a lean ore,—terms which are at times thought to be



CITY OF ISHPEMING, MICHIGAN—LOOKING SOUTH.

[Barnum mine workings in foreground.]

PIT OF BUFFALO MINE—LOOKING EAST.

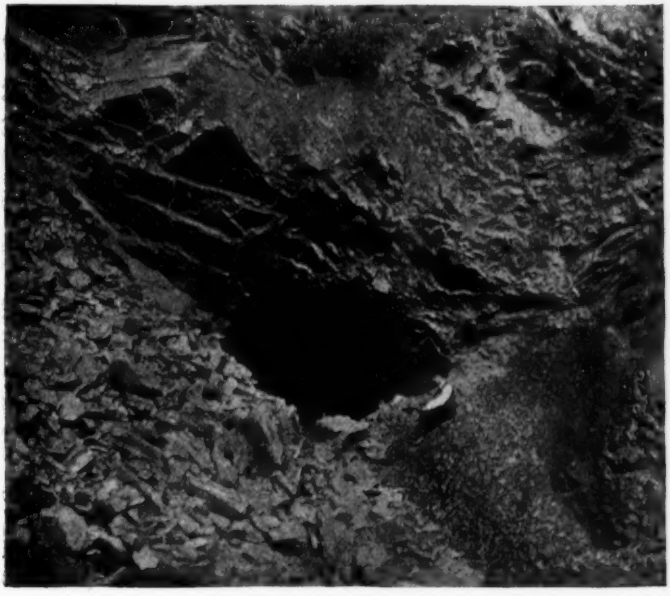
synonymous. A limonite of this district may be taken as a typical *low* grade ore; while a lean ore type would be found in the hematites carrying an abnormal amount of silica in the form of jasper or quartz. The former is reduced with a minimum of fuel, while the latter would demand an excessive amount of lime to slag off the silica, which in turn would call for heavy fuel consumption. There are times when a silicious ore is needed and used by furnaces, but only when a special grade of iron is wanted.

A list of the names of the mines having features of interest would embrace every mine capable of making an output of 50,000 or more tons of ore. The old Jackson at Negaunee is still operating; also the Negaunee and the Buffalo group of mines lying southeast of the town; the Volunteer at Palmer; the Lake Superior, Cleveland Cliffs Co.'s several mines, the Lake Angeline, with its phenomenal deposits of high-grade hematite, the Mitchel and Winthrop, all in the town of, or adjacent to, Ishpeming. There the Humboldt, Republic, Champion, and Michigamme companies pos-

sess mines of hard ore which have made their names known throughout the iron world.

A technical or detailed description of the various methods employed for winning the ore from the ground will not be attempted here. The illustrations which accompany this article will give a fair idea of the nature of the improvements made upon the surface and the character of the machinery employed. Many of the mines of the iron districts have achieved considerable depth by the aid of this improved machinery, the deepest being the Hamilton mine upon the Menominee range, to which reference will be made later.

The removal of the water of Lake Angeline, about a mile south of the city of Ishpeming, has been an undertaking of considerable importance and value. A lake covering an area of 103 acres, and 45 feet deep at its deepest portion, was emptied of its water in order to permit the mining of the iron ore lying beneath it, and to



LOOKING NORTHWEST IN CAVED GROUND OF BUFFALO.

[Between old open pit and caved ground is shown cap-rock and foot-wall.]

do it with safety. So long as the water remained above the miners, it was a menace to them, and the only solution of the problem was to remove it. Various ideas were advanced, but finally it was decided to cut down the outlet as much as the topography of the country would profitably allow (about six feet) and pump the rest of the water. The water has been removed, but the remaining mud, which is in places over 30 feet deep, has been the source of some apprehension and will prove more difficult of removal than the water. The Lake Angeline mine is now engaged in mining by the caving system at the east end of the Lake, while the Lake Superior and Cleveland Cliffs companies have their ground, lying under the bed of the lake, all developed and explored, ready to make a very heavy shipment, so soon as the mud

BUFFALO MINE—LOOKING WEST.—NO. 2 SHAFT.
[Prince of Wales mine in distance.]

is removed and the condition of the market will permit sale of its ore. At the Champion mine in Michigan and the mines of the Minnesota Iron Co., of Minnesota, producing hard ores, the latest plant improvement consists of large 65-ton ore-crushers, built upon the general plan of the Blake rock-crusher. The opening at the mouth of the jaws is 24 inches by 24 inches, and ore is crushed down to 2½ inch pieces; to do this, an engine of about 100 horse power is employed; the crusher can break from 800 to 1000 tons every ten hours. The ore is run directly into railroad cars after crushing, whence it is shipped to the docks at Marquette, which are illustrated on another page.

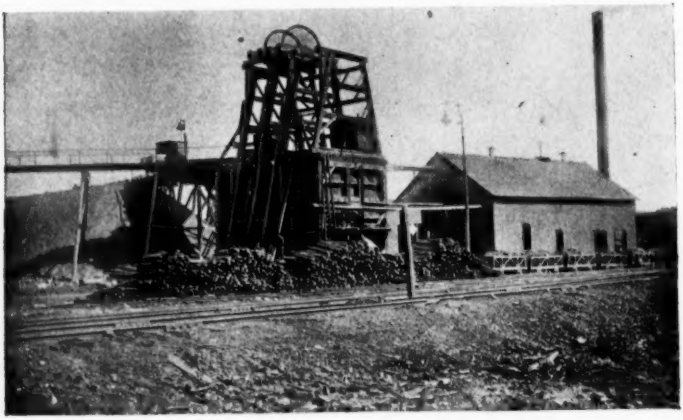
The total output of the Marquette range since its opening up

LAKE ANGELINE (LOOKING WEST) BEFORE WATER WAS PUMPED OUT.

to the end of the year 1892 has been 37,924,968 long tons of all kinds and grades.

THE MENOMINEE RANGE.

The Menominee range occupies a position upon the southern boundary of the Upper Peninsula, midway between its eastern and western extremities. It lies for the most part in Michigan, but a few of its mines are in Wisconsin. The general trend of the range is north of west, and it is persistent and regular in its course. It is about fifty miles in length, twenty of them lying east of the Menominee river, the remainder west of it. The first location upon the range was made at the eastern end by the Breen brothers near the present town of Waucedah in 1866, but nothing was accom-



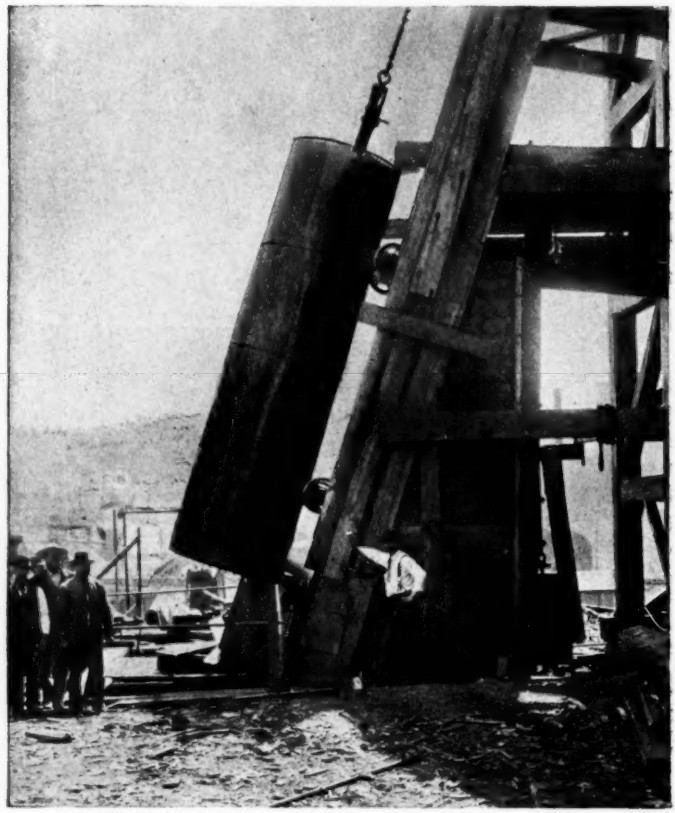
NO. 1 QUEEN SHAFT—LOOKING EAST.

plished towards establishing the value of the range until 1872. The panic of 1873 brought explorations to a sudden stop, and they were not resumed until 1876. In 1872 Dr. N. P. Hulst, chemist for the Milwaukee Iron Company, was sent to the range to develop and explore it; roads had to be surveyed and cut, camps established, and men obtained, so that it was not until the fall of 1873 that an ore of merchantable grade was found by explorers working under his direction. Three mines were found that year, the Breen, West Vulcan, and Metropolitan, when the panic stopped further development. To the Breen brothers belongs the honor of first finding ore upon the range, but to Dr. Hulst belongs the credit of systematically

LOOKING SOUTH-WEST TOWARDS QUEEN. OLD NO. 1 SHAFT, WHERE LADDER SHOWS.

and intelligently exploring it and giving to the Upper Peninsula this valuable territory.

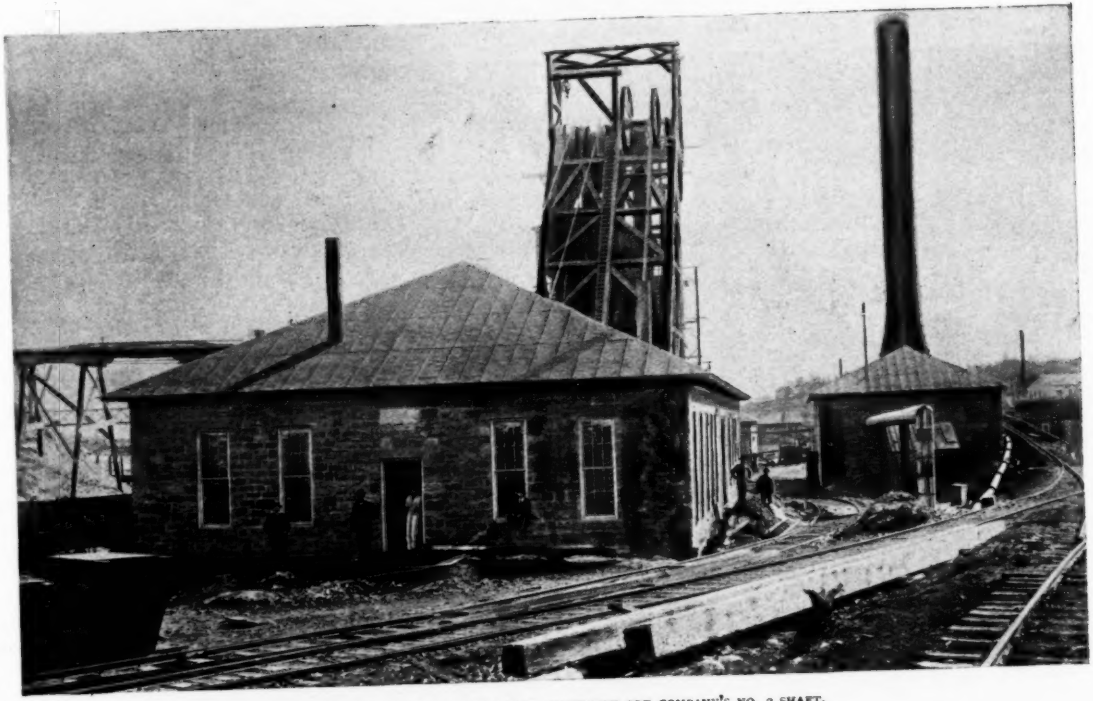
The same general series of rocks are found in this as in the Marquette range, with the additional feature of Silurian limestone overlying the Huronian series, an occurrence not seen in the older range. The latter series pass under (near Breen) the Silurian rocks, but are not terminated by it. Running parallel with the range and north of it is a belt of dolomitic limestone, with an occasional break in its outcrop, and with a dip to the north; filling in various



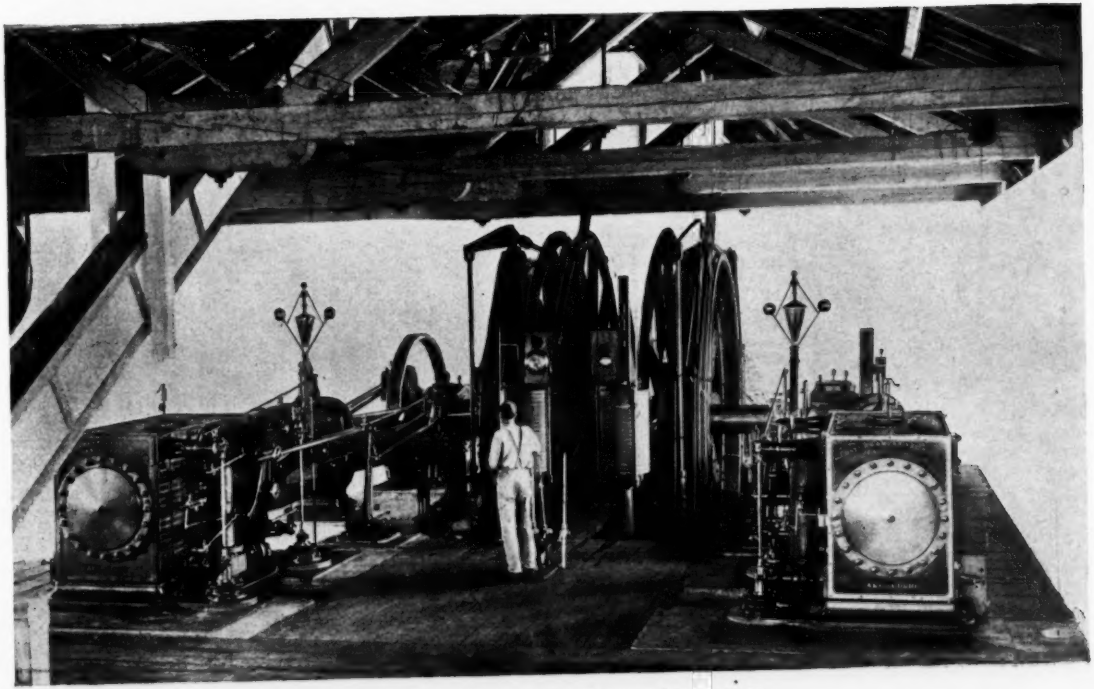
WATER DISCHARGING FROM SMALL BALER OF LUDINGTON MINE.
[Chapin workings in the distance.]

LAKE ANGELINE, LOOKING WEST, AFTER MAIN BODY OF WATER HAS BEEN PUMPED OUT.

[Cleveland Cliff Company's lake shaft on the extreme right; Lake Angeline Company's new shaft on the left. The ore lies in a fold of diorite which outcrops north and south of the arms of the lake.]



BOILER, ENGINE, AND SHAFT-HOUSE—HAMILTON ORE COMPANY'S NO. 2 SHAFT.



HOISTING ENGINE OF HAMILTON ORE COMPANY'S NO. 2 SHAFT.

HAMILTON ORE COMPANY'S NO. 2 SHAFT HOUSE.
[Looking east. Water discharging from bottom of baler.]

depressions in the Huronian rocks, and now found near the caps of hills, are isolated patches of Silurian limestone, which once overlaid the ore-bearing Huronian rocks. Glacial action cut great valleys and gullies in this limestone, leaving caps of it upon the tops of the hills. North and south of the dolomitic limestone,

which has a width of approximately 1700 feet, ore-deposits have been found, the ore lying north having quartzite as an overlying rock, while the ore to the south of it has a group of slates locally known as the Hanbury group, which have a thickness of probably 1000 feet : in these two horizons ore is looked for, and many very valuable properties have here been discovered. The foregoing outline serves to briefly describe the conditions east of the Menominee river. West of it the ore occurs mainly in a horizon of jasper-schists, which are locally associated with graphitic slates. Bended, twisted, and folded, the strata enclosing the ore occur with varying pitches and dips. At the extreme eastern end of the range the dip is to the south, which appears to be the normal dip of the district ; while at Iron Mountain the folds cause the ore to stand with a pitch to the north.

The mine of greatest interest from its age and output is located at the above turn and is known as the Chapin. It was discovered in 1879 and has made a phenomenal record for output. In 1880 it shipped 34,556 long tons, reached its maximum of 742,843 tons in 1890, and has shipped to the beginning of 1893 a total of 4,367,-344 tons. The surface plant of this mine is one of the most complete to be found in the iron districts ; the machinery is mainly driven by compressed air, which is carried a distance of three miles through a 24-inch iron pipe. Quennesec Falls of the Menominee river furnish, under a head of 52 feet, water to supply three 48 inch and one 54-inch turbines ; these latter operate air compressors, which furnish the air at 60 pounds per square inch for over 100 power drills, and all the hoisting machinery. Boiler power is also available in case of accident or repair being called for by the water-power plant. Ore has been found in four large lenses, but operations are practically confined to what is known as the Chapin or main lens. It is attacked through four shafts, ranging from 350 to 700 feet in depth. The fourth shaft was sunk by the Poetsch freezing method through 90 feet of quicksand. This was accomplished by driving a circle 30 feet in diameter of iron pipes, which were connected to a refrigerating machine ; this reduced the temperature of the ground surrounding the pipes to about zero, freezing it and enabling miners to drill, pick, and blast it like solid ground. An immense Cornish lift pump has been built for this mine, which operates its rods in this shaft. This pump was designed to handle 3000 gallons of water from a depth of 1500 feet vertically. It is the largest mine pump in the iron dis-

BARNUM MINE AND STOCKPILES; OPERATED BY THE CLEVELAND CLIFFS COMPANY.

trict. The ore is broken by power drills and dynamite (containing from 27 to 45 per cent. nitroglycerin), and is loaded on mine cars which are automatically trammed to a shaft, hoisted to the surface, there taken by a railroad car through a pocket with gates, or out over a trestle to the stock pile from which the ore is afterward loaded on railroad cars by means of a steam shovel. By this means a car holding 20 to 22 tons has been loaded in four minutes.

As showing the faith of iron men in the continuity of ore deposits in depth, the Hamilton Ore Co., through its agent, John T. Jones, began diamond drilling north of the Chapin line, and found ore at a depth of over 700 feet from the surface. This ore was identical in every respect with that found in the Chapin, and subsequent development has proved that the great Chapin lens extends by its dip and westward pitch into the adjoining land, north and west. A shaft was sunk in the extreme southwest corner of the land acquired by the Hamilton Ore Co. to a depth of nearly 700 feet before ore was found. The shaft then remained for some time in ore as it deepened and finally passed into the underlying footwall of jasper.

The main shaft has reached a depth of 1325 feet vertically from the surface, while a winze has been sunk over 130 feet additional; making the total depth from the surface over 1450 feet. A second shaft was started after exploiting the ground through the original shaft. This shaft had reached a depth of nearly 1400 feet from the surface when the drillers encountered a seam of water, which drove them out and finally filled the shaft. At a depth of 1325 feet a cross cut to reach the old mine had been started.

Shortly after, the mine adjoining on the west, the Ludington, became flooded by an influx of water from the hanging wall, which was so powerful as to drown the mine-pumps, and many of the men had a close call in escaping the deluge. The water rose with great rapidity and finally reached a level which communicated through No. 1 shaft of the Hamilton mine with the underground workings of that mine. The water poured over into this shaft in torrents and filled the lower workings of the mine. After standing idle for over a year, and the control of the Ludington mine having passed into the hands of the Hamilton Ore Co., plans were completed whereby the mines were to be unwatered. Large balers capable of containing eleven tons of water were made, and the large engines, which had been designed to hoist ten long tons of iron ore, were put into use; in fact, all the hoisting appliances

of both mines were temporarily pressed into the service of raising water. The engines used at the No. 2 shaft of the Hamilton mine are the largest ever built for hoisting in the iron districts, and a few figures concerning them and their performance may be of interest. They are of the first-motion Corliss type, with cylinders 32 inches bore by 72 inches stroke, coupled with cranks at right angles, and are fitted with two winding reels, each capable of carrying 2500 feet of 8-inch by $\frac{7}{8}$-inch flat wire rope (the largest flat rope ever made or used in this country, and intended to carry a load of ten long tons of iron ore in addition to the weight of the skip, from the maximum depth of the shaft). The reverse-motion friction clutches are all operated by hydraulic cylinders. The plant weighs 165 tons and hoists its load at a speed of 2000 feet per minute. A test of the engines and boiler plant (six, return flue, tubular style) was made in April, 1892, with the following creditable result:

Length of test	5 hours
Average height hoisted	1,146 feet
Buckets of water hoisted	179
Pounds of water hoisted	3,978,722
Foot pounds of work	4,559,615,412
Amount of water evaporated	95,472 pounds
Total indicated horse power	587
Pounds of water per H. P. per hour	30.6
Foot pounds per 100 lbs. fuel	69,058,762

The balers are run in balance, and 2500 gallons per minute have been raised from a depth of 1325 feet, with a consumption of 26,520 pounds of coal in 24 hours. It would have been out of the question to attempt to unwater the mine with pumps, and it could not have been done in any other way in such a short time, six weeks proving to be the time required. When water was lowered to the 1325-foot level in No. 2 shaft, the miners continued the cross-cut into the old workings and before the water contained had been removed; the object being to tap that body of water and allow it to flow into No. 2 shaft and be raised by the large balers. Diamond-drill holes were kept ahead of the face of the cross-cut, so as to insure the safety of the miners, until one day one of the holes, in line with the cross-cut, tapped the old workings, and air, compressed and hissing, notified the miners that it was time to prepare the final charges to break down the bulkhead of rock separating them from the old mine. The presence of air is ac-

counted for by reason of the water flowing in from the Ludington mine, down the No. 1 shaft of the Hamilton, forcing it ahead up to the ends of the drifts and levels:

HAMILTON AND LUDINGTON MINES. PUMP REPORT.—JULY 9, 1893.

	Total hours hoisting to date.	Total No. of Gallons to date.
Hamilton No. 2 Shaft, large hoist	413	47,286,400
Hamilton No. 2 Shaft, small hoist	327	10,665,600
Ludington "A" Shaft	139	4,687,411
Ludington "B" Shaft	276	10,832,875
Ludington No. 5 Shaft	16½	676,568
Cornish Pump	244	4,482,000
Total	—	78,630,854

Water lowered 891 feet.

R. H. FLAHERTY, Superintendent.

The suddenness of inflow of water and the work subsequently undertaken to unwater the mines show the value of mines maintaining a complete and "up-to-date" map of the underground workings. With such maps work is intelligently and accurately planned, and the cost of making and maintaining them saved a hundred fold in the driving of accurately planned draining drifts. In this case the new cross-cut from No. 2 shaft met the face of an old "room," exactly as planned,—the drill holes being made as a precautionary measure, and in case there was an error in the mine-maps.

West of Iron Mountain and crossing the border of the State line, into Wisconsin, there are two large properties whose ore is of a non-bessemer (or non steel-making) nature, but whose output, since their discovery in 1880 up to the end of 1892, has been over a million tons. Reference is made to the Florence and Commonwealth mines. But to give a description of individual properties would involve too detailed a statement and be, in a great measure, a repetition.

Since its early opening and development in 1878, when four mines sent to market by way of the lake port, Escanaba, 78,028 long tons of ore, up to the end of 1892, this range has sent away 16,779,261 long tons.

THE HISTORY OF STRIKES IN AMERICA—I.

By Arthur A. Freeman.

THE belief still persists in the minds of many that, whatever may be the case in the old world, this country at least would be tolerably free from industrial conflicts and acute crises in the world of employer and employed, if it were not for the pernicious and wicked activity of labor agitators. Such a view, however, does not find support in reason or experience. It is irrational to ascribe the existence of labor troubles in this country to any individual agency. No one cause is adequate as an explanation of the rise and development of the labor movement. There have been many influences and agencies at work, and the only way to trace them and arrive at the correct view of the subject as a whole is to consult the records and employ the historical method. A review of the history of strikes in this country will enable us to determine whether or not labor disturbances are novel in our industrial history and merely the fruit of the new great labor organizations. Everybody is aware that strikes, lockouts, and violent collisions have been frequent since 1877; but not many are conversant with the history of the labor movement prior to that date.

In the early days shipbuilding was the most important industry of the colonists, and this necessitated the bringing over of a large number of skilled craftsmen from England. The shipworkers came mostly from Kent, where organizations of labor existed at that time, and naturally maintained the rules which governed their craft at home. They were strong and vigorous men, and their hours of labor were from sun to sun. Shortly after the close of the first century and a half of the history of the colonies, the wage question began to be discussed. The labor associations of that time were mostly of a purely social character, however, with benevolent features.

The earliest example of the strike known in this country, is undoubtedly the baker's "conspiracy" of 1741. Some journeymen bakers of New York city conspired to refuse to bake bread till their wages were raised. The records of New York criminal proceedings show that an information was preferred against the conspirators for combining not to bake except on certain terms, and that they

were duly tried and convicted on this charge. No sentence appears to have been passed, however; probably some technical point prevented the infliction of the punishment. Our notions of criminal conspiracy are not much clearer to-day than they were in 1741, though none of our courts would enunciate the bold proposition that it is criminal to conspire to raise wages.

In 1777 the town of Newburyport, Mass., passed a vote to establish a maximum rate of wages pursuant to an act of the General Court "to prevent monopoly and oppression." The maximum for carpenters was 5 shillings 4 pence a day; for caulkers, 6 shillings; for joiners, 4; for masons, 6. More than this the masters were prohibited from paying; less than this they were allowed to pay.

For the next recorded strike we must refer to a much later date. An association of journeymen shoemakers was organized in Philadelphia in 1792, and in 1796 a "turnout" was ordered by this organization for an increase of wages. The strike was successful, too. In 1798 the same body again struck for an increase of wages, and again scored a victory. In 1799, we find this organization again up in arms; this time to resist a reduction. The strike lasted ten weeks, and was a partial success. The association numbered over one hundred members.

In 1803 the notorious "Sailors' Strike" occurred in New York city. A number of sailors demanded an increase in wages. To obtain it, they formed in a body, marched around the city, and compelled those seamen who remained at work to leave their ships and join the strikers. Constables arrested the leader and dispersed the strikers, causing the collapse of the strike. It is rather remarkable to find the strikers of 1803 employing such modern methods as street parades and coercion of the "scabs."

In 1805 our Philadelphia journeymen shoemakers' union is again in evidence. Another strike is ordered for an increase of wages, which, after several weeks, fails. This strike is historical, for a remarkable conspiracy trial grew out of it. Eight men were tried on an indictment containing three counts. The first count charged that the defendants had contrived "unjustly and offensively" to increase the market price for their services, to the damage and prejudice not only of the masters, but of other journeymen (!), the citizens generally, and the dignity of the State. The second count referred to the agreement to prevent other workmen, by *threats and other unlawful means*, from continuing to work on the old terms; while the third count recited that they had

unlawfully met and tried to form themselves into a club and ordain "arbitrary and unlawful" by-laws for their own guidance as well as for the government of other workmen. These "arbitrary" by-laws were simply the agreement not to work for the old rates. Much testimony was taken at the trial, one master alleging great annual losses through inability to fulfill his contracts consequent upon the refusal of the union to allow its members to work with non-members. It was also brought out that the union men had used threats and violence to secure the coöperation of refractory workmen, and that the system of boycotting was in full operation.

Very remarkable indeed is the charge of the recorder, and especially curious are his politico-economic propositions. The usual means, said the recorder, by which the prices of work are regulated, are the demand for the article and the excellence of its fabric, and to make an arbitrary and artificial regulation without regard to the excellence of the work or the demand for it, is an unnatural way of raising the price of labor. Such an unnatural way exposes commerce to ruin and is therefore against the public welfare. The recorder went on to condemn boycotting and all forms of indirect coercion. A combination of workmen, he said, to raise wages, may be considered in a twofold point of view: one is to benefit themselves, the other is to injure outsiders. The rule of law condemns both. A combination may not attempt to raise wages in ways perfectly allowable to individuals.

The jury found the defendants "guilty of a combination to raise their wages," and they were each fined $8 with costs.

In 1806 the tailors organized a trade-union. Prior to that date members of that craft coming from England continued their membership in the tailors' unions of the old country. The same is true of the hatters, who organized their first union here in 1819.

In 1809 the New York journeymen cordwainers' association ordered a general strike against all the masters. A strike in one of the shops had been defeated by the proprietor taking his work privately to other shops. In the general strike about 200 men were involved. In this strike the term "scab" first became current. A conspiracy trial followed, and a verdict of guilty secured. The defendants were fined only $1 with costs each. The indictment in this trial was almost a copy of that upon which the Philadelphia shoemakers were tried, but the judge's charge to the jury was very different. The court declared that it was by no means clear that an agreement not to work except for certain wages was in it-

self illegal, and laid stress on the fact that the offense of the strikers consisted solely in the use of unlawful means to obtain their object. The "unlawful means" were the coercion of non-unionists and the ordering of strikes against masters not directly involved in the quarrel.

The next strike and attendant conspiracy trial occurred in 1815. Pittsburgh was the scene and the journeymen cordwainers were the strikers and defendants. The indictment presents nothing new, but the judge's charge again marks an advance in opinion on the subject of conspiracy. The political economy of the Philadelphia recorder is gently brushed aside, the court laying down the proposition that the jury has nothing whatever to do with the question of regulating prices, wages, or profits. "It has been truly said," held the court, "that every man has a right to affix what price he pleases on his labor. It is not for demanding high prices that these men are indicted, but for employing unlawful means." Here, too, the "unlawful means" referred to are boycotting and coercion of outsiders. The court's distinction between legitimate and illegitimate boycotting is still followed in our courts. "You have a right," said the court, "to have your boots, coat, or hat made by whom you please. You may advise your neighbor not to employ a particular mechanic. But should you confederate with others to ruin any particular shoemaker, tailor, or hatter, by preventing persons from employing him, this would be unlawful." The strikers were convicted.

In 1821 the first printers' strike occured. It was ordered by an Albany typographical union because of the employment of a "rat" in one of the offices.

In 1822 it was the turn of the New York journeymen hatters to strike and be tried and convicted for conspiracy. But greater interest attaches to the strike and conspiracy trial of 1827. Some Philadelphia tailors struck to secure the reinstatement of five journeymen who had been dismissed for demanding higher pay for a particular job. New employés were followed in the streets, threatened, and induced to quit work, while workmen in other shops were induced to refuse to work as long as their employers continued to receive work from the shops concerned in the strike. The judge in this case dwelt on the use of illegal means, but the jury found the defendants guilty only on one count,—that charging conspiracy to compel masters to re-employ discharged workmen.

During the years 1825-1830 the ship-carpenters and caulkers in

New York city and along the Atlantic coast were agitating the ten-hour day question, and small strikes in those trades were of frequent occurrence, sometimes succeeding and sometimes failing. It is remarkable that some of the employers looked with favor on the ten-hour day, and expressed willingness to pay the men by the hour and allow them to make ten hours their limit. In 1832, however, a meeting called by the master mechanics to consider the expediency of adopting the ten-hour plan passed resolutions against the proposal. The merchants and ship owners of Boston, then the center of the agitation, had become so weary of strikes and disputes that they held a meeting and passed resolutions declaring that they will employ no journeyman belonging to any labor association nor give work to any master mechanic or contractor employing such journeymen. The merchants might have been indicted for conspiracy, had the workmen traced the ruin of any particular contractor to the agreement of the merchants; but there is no record of any attempt to indict the merchants.

In the same year several hundred workmen in New Bedford struck for the purpose of regulating the hours of labor; they held meetings and employed the town-crier to announce them.

In 1833 several strikes occurred, two of which led to conspiracy trials. One of these is the strike of the Thompsonville, Conn., carpet factory employés for an increase of wages. Suit was brought against the strikers for conspiring to raise the "price of wages" and hindering other weavers from going into the employ of the plaintiff. The great point in the case was whether "peaceably conspiring" or arguing with the workmen to refuse to work for less than a named sum, constituted a ground for civil action on the part of the employer. The case consumed a week. The court charged the jury in the negative, and the verdict was for the defendants.

The other case is that of the Geneva, N. Y., journeymen shoemakers who struck in a body against the refusal of the employers to dismiss one of the men who failed to live up to the rules of the union. The strike was successful, but the strikers were indicted and tried for conspiracy. The indictment charged the strikers with having formed themselves into an unlawful club and conspired to prevent journeymen from working below certain rates prescribed by them, and with having agreed, in pursuance of the general conspiracy, not to work for any master who should employ the journeyman obnoxious to them, although he was a good and

free citizen and faithful workman. The court gave judgment in favor of the strikers, on the ground that the indictment did not specify an offense known to the laws of the State. But the district attorney sued out a writ of error, and the case was carried up to the supreme court, which reversed the judgment of the lower court, holding that the conspiracy was indictable because it was an act *injurious to trade.* It is important to the best interest of society, reasoned the court, that the price of labor be left to regulate itself, or rather be limited to the demand for it. Combinations to enhance or reduce the natural price are injurious. If the bootmakers may say that boots shall not be made for less than $1 per pair, it is optional with them to say that $10 or $50 shall be the price, and the result would be an odious monopoly and an enormous tax upon the community. Still if any man thinks the fixed price too low, he may refuse to work for it; what he has no right to say is that no other workman shall accept it.

In 1834 the female shoebinders of Lynn, Mass., struck for an increase of wages, and failed. They refused to take work to their homes, but the employers found no difficulty in getting the women of neighboring towns to take it. In the same year the Lowell female factory operatives struck on account of a reduction of wages. Other strikes occurred, but the most important strike of the year was that of the laborers employed at Mansfield, Mass., upon the construction of the Providence railroad. The strike resulted in a riot, which had to be suppressed by a company of militia. For the first time we here find the militia playing a part in the struggle between labor and capital.

In 1835 fifteen strikes occurred in different parts of the country. The stone cutters of New York and other cities succeeded in securing a ten-hour work day, and workmen in Philadelphia coal-yards, who also desired the ten-hour system, succeeded in obtaining assent to the proposition that "they work from sunrise to sunset, with an intermission of three hours, these to be designated by the workmen." Other Philadelphia workmen succeeded in establishing the ten-hour system, a certain firm taking occasion to say that it was their "candid impression that if a man works ten hours a day, it is all-sufficient." The city council also resolved that the hours of labor for city employés shall be from 6 to 6, allowing one hour for breakfast and one for dinner. The city also raised the wages of certain of its employés. Working-women of Philadelphia having met to form a new scale of prices, the master bookbinders

"considered the cause of female laborers as one whose claims were founded on justice," and deprecating the course of greedy and unscrupulous employers, resolved "that $3 per week is the least amount of wages those possessed of the principles of humanity could offer."

In 1836 seven strikes occurred. The most serious were the strikes of the longshoremen, riggers and others connected with shipping in New York and Philadelphia. The strikers demanded a reduction of hours and an increase of wages, and threatened the new men employed. The affair was settled by the military. Equally important was the New York tailors' strike for an increase of wages. By threats they kept others from working except at union rates. Several hundred of them paraded the streets with music and banners. Twenty-one of them were tried for conspiracy, convicted, and sentenced to pay fines ranging from $100 to $150. The judge in this case followed the decision of the supreme court in the case of the Geneva shoemakers just referred to. In his charge, he impressed on the minds of the jury that the case was not to be considered "a mere struggle between master and journeyman." It was one on which the harmony of the whole community depended. "Let these societies only arise from time to time, and they will at last extend to every trade in the city, and there will be as many governments as there are societies." The judge declared that there was "no necessity for such societies. Combinations were not necessary in this country for the protection of mechanics or any other class. They were of foreign origin, not in harmony with our institutions or national character, and they were mainly upheld by foreigners."

The year 1837 had two strikes. The employés of a Rochester N. Y., contractor struck for an increase of wages. The Rochester *Democrat*, saying that "there is a settled determination among the laborers neither to comply with the terms of the contractors themselves nor to allow others to do so," adds that the workmen "cannot be censured for refusing to work fifteen hours for six shillings." In Boston, sailors struck for an advance from $14 to $16 per month. The demand was refused on the ground of commercial depression. Street processions and rioting followed. Within a week the strike failed.

In 1838 there was a strike of factory girls at Dover, N. H., against a proposed cut-down. The girls placarded the fences and office-doors with rhymes abusing the employers and overseers.

There is no record of the result. In 1839 there were two strikes of railroad laborers. One was on the Eastern railroad, near Salem, Mass., the demand being a shorter work-day. The other strike was on the sections between Reading and Hamburg, Pa., for an increase from $1 to $1.12½ per day, and, in some cases, for more whiskey, the allowance being 1½ pints per day for each man, dealt out in nine doses. The wages were increased on one section, but to the appeal for more whiskey the contractors turned a deaf ear. In 1840 railroad laborers in Rawley, Mass., struck in consequence of certain workmen having suffered deductions of pay for failing to begin work at the required hour. New men were prevented from working, an overseer was attacked, and attempts were made to destroy property. But the rioters were dispersed, the ringleaders arrested, and work was resumed as usual.

The year 1842 is remarkable for the first appearance of the iron industry on the scene of strikes. In February boilers in the rolling mills at Pittsburgh struck against a reduction of wages to $5 per ton. In July the strikers resumed work at the reduced rate, which prevailed until 1845. In the same year a serious strike of Philadelphia weavers occurred on a question of wages. The strikers who desired to return were intimidated, and many violent attacks were made on the mills, resulting in destruction of looms and chains. The riotous proceedings continued into January, 1843, when the difficulties were amicably adjusted.

In 1843 there were strikes of female operatives in Philadelphia and Chicopee, Mass. An important strike was that of the West Philadelphia bricklayers for higher wages. There were parades, attacks on fire companies, and destruction of property. The mayor and sheriff refused to interfere because the county had not paid the last posse called out. There were other minor strikes. In 1844 Philadelphia had three strikes for higher wages; no other strikes are recorded. In 1845 the boilers in the rolling mills of Pittsburg struck and received an advance of $1 per ton. The price of boiling remained at $6 per ton until 1850. There were four other strikes, three of them successful. In 1846 only one strike occurred, and it failed.

During 1847 many strikes prevailed, some for shorter hours and some for higher wages; some of them were successful. The high price of provisions was a fruitful source of strikes; flour went up to $14 per barrel in the early part of the year. The ship builders of Bath made an effort to break down the ten-hour system. When the

short days of the winter had passed, the employers demanded the old system of working from sun to sun, and for some weeks the industry was at a standstill. But public opinion was on the side of the workmen, and the employers were finally forced to yield.

In 1848 the strikes were few in number but very violent. The Fall River weavers struck against a reduction. The mills were closed three weeks. There was considerable rioting, and some of the strikers were sent to prison for disturbing the peace. The strike failed. The coal miners on the Monongahela river struck against a reduction, and made violent demonstrations. A number of mills shut down, and others reduced wages. Seven cotton factories of Allegheny City shut down in consequence of a dispute with the men, and 2000 operatives were thrown out of work. There was furious rioting and attacks on the mills. A number of rioters were arrested, tried, and found guilty. Finally the factories resumed on the ten-hour plan with a reduction of 16 per cent. in wages.

In 1849 there was only one strike at a cotton mill, and it failed. In 1850 business was dull throughout the country. Out of 2,485,-700 spindles in New England over 800,000 are said to have been stopped. The Fall River mills gave notice of a reduction of wages, and a strike of great magnitude followed causing widespread suffering. Arbitration was suggested by a workman, but the suggestion received no attention. During nearly six months 1300 persons were idle. Finally the reduced rates were accepted. The Pittsburgh iron workers also struck against a proposed reduction, but the mills started with imported workmen. There were serious disturbances and an attack on one of the mills. Arrests were made and many men and women were sentenced to imprisonment and fines. The strikers were subsequently pardoned by the governor on petition of part of the jury and a large number of citizens. During the years 1850 and 1851 strikes for the ten-hour system occurred in many industries, but most of them failed, owing to the increasing immigration of foreign workmen.

In 1852, besides a number of minor strikes, there was a remarkable strike at the Salisbury, Mass., mills. The employés, members of the oldest families in town, had for thirty years enjoyed the privilege of fifteen minutes during each half day for luncheon. Owing to the abuse of this privilege it was suddenly abolished. A hundred employés disregarded the order and were dismissed; the female weavers thereupon went out on a "sympathetic" strike The whole town debated the question. The strike was joined by

the employés of the Amesbury mills, where the luncheon privilege had also been suddenly abolished. At length the mills were started with Irish help, and the former operatives gradually left the places. The town suffered greatly from the crippling of its chief industry and the depreciation of property.

There were twelve strikes in 1853; most of them failed. In some cases shorter hours were granted. In 1854 ten strikes occurred, the most notable of which was the strike of the compositors of the Philadelphia *Register*, who objected to the employment of girls in the jobbing department. Some of the strikers were arrested and charged with conspiracy to prevent the issue of the paper. Only three strikes occurred in 1855, one of them,—that of the cigarmakers at Suffield, Conn.,—lasting seven weeks. The strikers were financially supported by the cigarmakers of other cities. In 1856 Irish laborers upon the wharves in Boston struck against the introduction of the steam-hoisting machine, and were of course defeated. In 1857 there was a strike of five months' duration of glass blowers in Philadelphia. Owing to the hard times and the then universal truck system, workmen at other points were unable to send money to the strikers, but wagon loads of provisions were sent from the truck stores. Two other strikes occurred in that year. In 1858 the iron workers organized their first union, "United Sons of Vulcan." There were four minor strikes and one strike of some importance. The female weavers and other employés at Chicopee, Mass., resisted a reduction. There was more or less rioting, which was suppressed by the police. Finally the reduction was accepted.

Nine strikes occurred in 1859, some of them of a serious character. The hatters' union ordered a strike against a dealer in Boston for refusing to observe its regulations in respect to the employment of apprentices and "scabs." The dealer held out three years, and then acceded to the demand of the union. The coal miners along the Monongahela valley and in certain counties in Pennsylvania struck against the irregular sizes of the cars. The strikers demanded that scales should be erected at the mouth of the pit to weigh each man's coal. Speakers were engaged, and the whole region was interested in the struggle. After a few months the strike collapsed on account of the poverty of the miners. Twenty-seven persons, men and women, were arrested and charged with riotous conduct, the women having stood at the entrances of the pit making the miners take oath that they would

not "blackleg" or work while part were on strike. Those arrested were tried and convicted, but the jury recommended them to mercy, and the judge only imposed fines of from $5 to $10 and costs. The year also witnessed a struggle between the glass-blowers and the manufacturers. An eventful meeting of the glass-blowers having been held, the manufacturers determined to break down the union and took in apprentices with the intention of throwing a large number of employed upon the union for support. The glass-blowers met this move by a resolution limiting the number of apprentices to two in a factory. A general strike ensued, and non-union men were imported by some manufacturers. Fourteen strikers were arrested for conspiracy. The strike failed, and the union fell with it and did not revive until 1865.

We have reached the end of the first epoch of the labor movement. The facts set forth warrant certain general conclusions to which attention should be drawn. We observe that during the first epoch,—that is, up till the war of the rebellion,—there were very few strikes against reductions of wages. The great majority were for shorter hours and increased pay; and this is a sure indication of general national prosperity. Labor manifestly felt strong, and any grievance seemed sufficient cause for a strike. No great organizations existed; the trades unions were small and weak; but labor felt that the country was new, rich, and undeveloped. The natural opportunities were open to all; land was practically free, and there was no pressing necessity for accepting low wages when an independent subsistence on the soil presented itself as a practicable alternative. The population was relatively small, while the natural resources were abundant and the avenues for enterprise almost innumerable. Money wages were lower, but so was the standard of living, while the fear of involuntary idleness scarcely existed at all. In fact, during the epoch under consideration we do not encounter any "problem of the unemployed," the chief reason doubtless being that the unoccupied public lands were ready to receive any portion of the army of industry for which there was no immediate need. The laborer felt secure and independent. It was natural for him to seek to improve his condition under such circumstances, and his strikes were demands for better terms, not protests against any encroachments on the part of employers.

When we come to treat of the second epoch of the labor movement, we shall find a great change in the conditions and a correspondingly great change in the character of the struggle.

THE NEWEST WARSHIPS OF THE UNITED STATES NAVY.

By Lieutenant W. H. Jaques, U. S. N.

NOT many years ago a distinguished citizen of the United States was asked to respond to the toast of "Our Navy." Rising slowly from his seat, he commenced by saying: "If the length of my reply is to be governed by the size of our navy, I have already said too much." Happily that period has passed, and we can point with some pride to the vessels of what so many have termed "Our New Navy." But even this is not enough; we have made but a commencement.

Since our first steel ship was built such progress has been made in the United States alone that already some of our types seem obsolete. This is not unnatural and should not for a moment stop the good work. On the contrary, it should be an encouragement for further development in the sciences of naval architecture and ordnance; for the granting of more opportunities to the minds who have already accomplished so much, and larger appropriations for the employment of native labor and for the spread of the technical education that is so valuable to the nation and its people. The space permitted for a sketch of any one of the important questions of the day covered by the standard magazines allows scarcely a chapter of the volumes that could be added to the debates and treatises already presented showing the necessity for the continuation of the reconstruction of the navy.

We hear the cry on all sides that no one will disturb us,—that even the strongest European powers fear our marvelous resources. These resources will no doubt eventually secure victory, but at what a cost! Meanwhile, increased wealth and consequent luxury, indiscriminate immigration, chronic dissensions in the South American and isthmian States, exclusion laws, and other causes are surely leading us into the midst of dangers that require the insurance of naval preparation, which should be all the more easy to secure, bringing as it will employment for native labor at a period when a labor crisis is imminent. It is not new to call this preparation an insurance, but I fear very few of either our legislators or our tax-payers realize how low a rate of taxation it requires. It is

not one-fourth of what we pay for the insurance on our homes or our lives, and yet the losses of life and property that a war, resulting from an absence of adequate insurance of this character, would cause are almost incalculable.

Following the lead of dating everything from this Columbian Exposition year, I shall attempt a description of our navy of 1893, taking advantage of prolific photography and transferography (if I may be allowed to coin a word) to present a more agreeable accompaniment to my tabulated history than dry technical phrases. Of those who advocate but one type of warship, the cruiser, I would ask, would you reform the army by abolishing everything but the cavalry? Heavy artillery and coast fortifications alone cannot protect the country any more than battle-ships. Just as the various lines and types of arms are requisite for the most efficient army, so are a variety of ships needed in the navy, if our personnel are to be victors in the struggles that will surely come for the vast wealth we are accumulating in the United States.

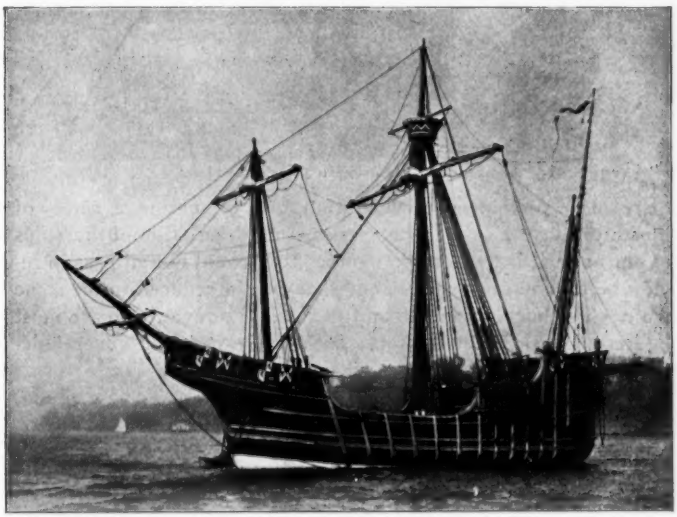
The growth of our commerce on the lakes* and the need of shorter water-routes must be firmly kept in mind. If a treaty prevents our actually placing on the lakes a warship more powerful than the unique *Michigan*, it cannot prevent our making suitable preparations for the care of our rapidly increasing wealth on these most important water-courses. Many of our readers will surely see the water-ways connecting the great lakes with the sea and the Nicaragua canal filled with ships bearing our flag and having the support of our army and navy; and these will then become the natural, although artificial, boundaries of the United States. We have made a feint in this direction by placing upon the lakes, perhaps in violation of the treaties, the brick battleship *Illinois*, quite as unique and harmless in another direction as our present paddle representative, but much more instructive to the people and an object lesson that must bring its benefits to the service it represents and to our legislators in their periodical struggles for appropriations.

The decision of the Navy Department to cover its exhibits in a "brick" ship was excellent. Hundreds of thousands of citizens and tax-payers of the United States have had an opportunity to learn what a battle-ship is, why she costs so much, what she contains, and what her purpose is; but it is to be regretted that sufficiently large appropriations were not made to enable the Depart-

*See THE ENGINEERING MAGAZINE, September, 1893.

ment to send a full crew of officers and men to still further interest and educate visitors to the World's Fair by having attractive drills and exercises.

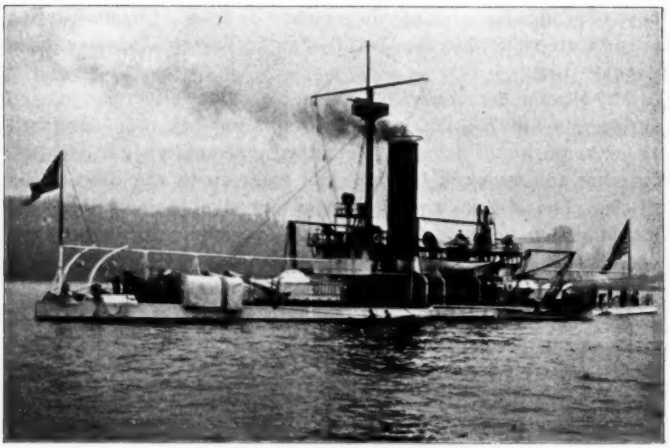
Mr. Horace See, America's eminent naval architect and marine engineer, in THE ENGINEERING MAGAZINE for July, 1891, described the inauguration of our new steel navy by Secretary (now Senator) Chandler and reviewed the progress made up to the date of his article. The *Atlanta* was the first of our steel cruisers to be put in commission, and it has been in continuous service for eight years. The *Chicago* and *Boston* have also shown the excellence of their



THE COLUMBUS CARAVEL, "SANTA MARIA."

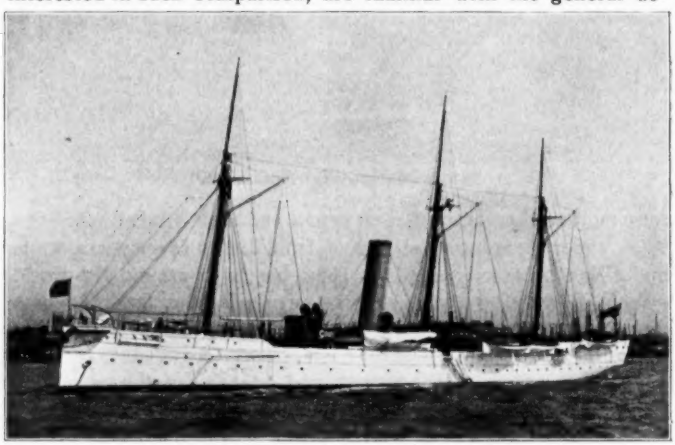
construction, the value of their types, and their general efficiency by an almost continuous service of from five to seven years, while the *Dolphin*, commissioned in 1885, has been around the world without developing that structural weakness the fear of which caused so much anxiety. She is now continuing the valuable diplomatic work in which she has been so actively engaged.

Without reviewing the history and qualities of the vessels by name, I have pictured them as far as possible in sequence of their christening, omitting duplicates of types, except in a few cases, and will call attention to the special elements of construction which re-



DOUBLE-TURRETTED MONITOR, "MIANTONOMAH."

quire more prominent consideration. In presenting a series of illustrations for a suitable comparison and description of the ships of our navy, it is to be regretted that they could not all pass in review before the same camera and focus, or be reduced to the same scale. The naval architect and engineer, however, who are most interested in such comparison, are familiar with the general de-

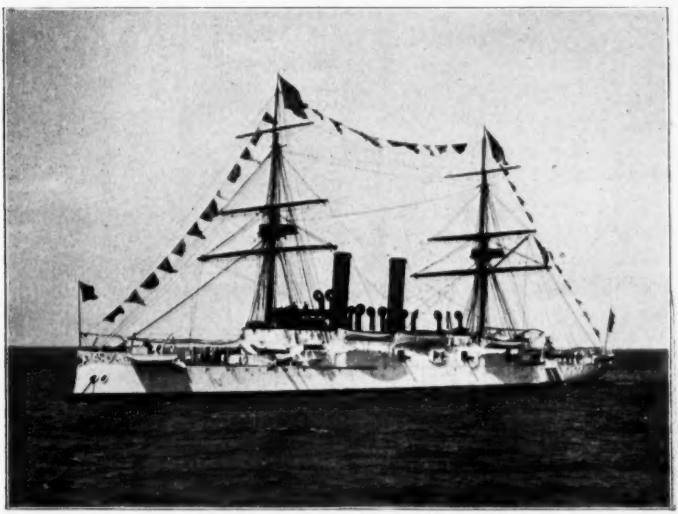


UNITED STATES DESPATCH-BOAT "DOLPHIN."

[Photograph Copyrighted, 1893, by J. S. Johnston.]

tails of our modern ships ; and the annexed table will give to others all the information for correct comparison.

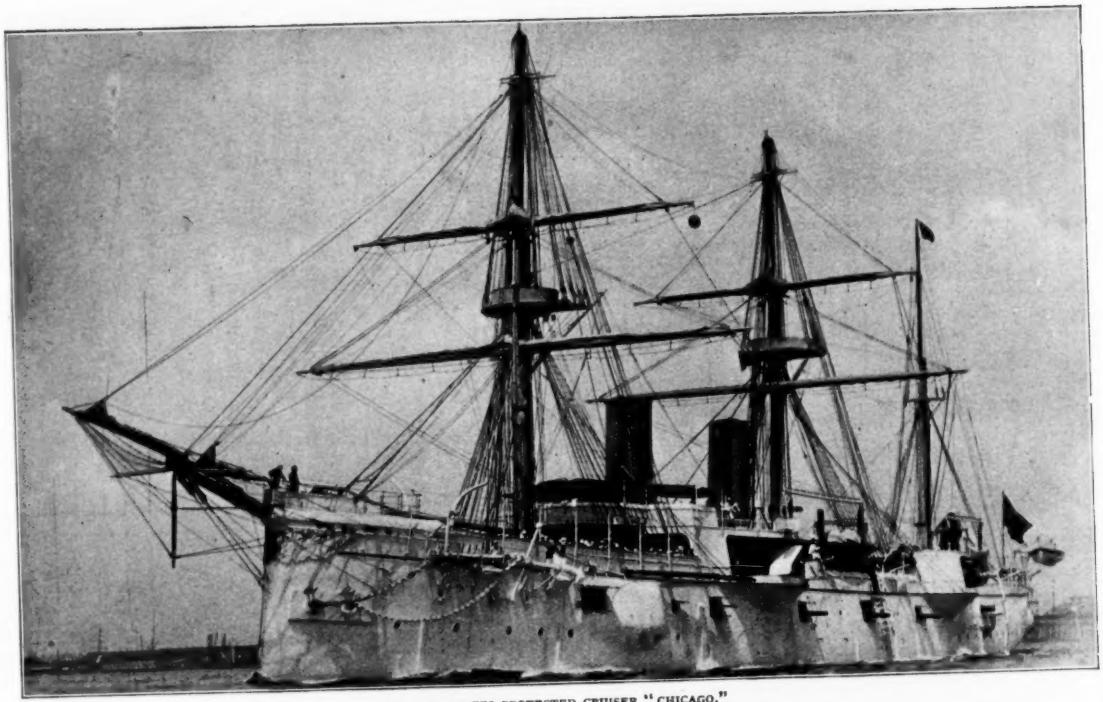
Our battle-ships must not be condemned because battle-ships of other nations have proved unmanageable or weak. They are of much less tonnage than the heaviest of the British and Italian navies. The former has seven ships of 14,150 tons displacement and one of 14,260 tons, carrying 67-ton guns ; the latter two ships of 15,900 tons, carrying heavier guns of less ballistic power ; while the *Indiana*, *Massachusetts*, and *Oregon* are 10,231-ton ships and the *Iowa* 11,286 tons, all carrying 57-ton 13-inch B. L. rifles for their heaviest calibers.



UNITED STATES PROTECTED CRUISER "ATLANTA."

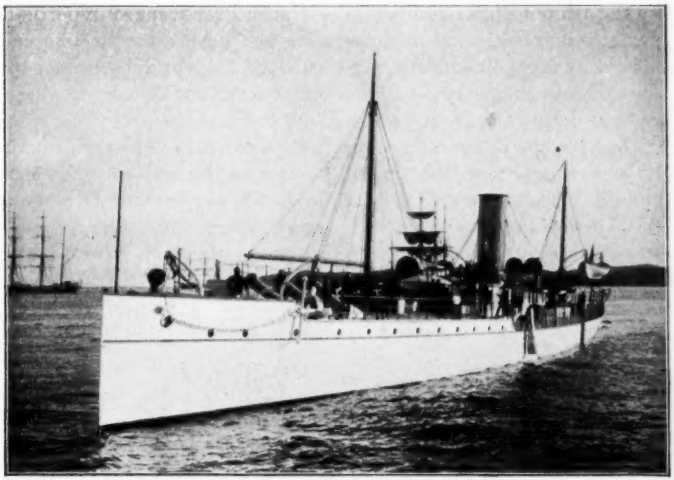
In 1887 the British ship *Victoria* was supposed to surpass every other battle-ship ever designed in points of power, protection, speed, and general efficiency. To-day she is at the bottom of the sea, the grave of 360 brave officers and men, victims of a fatal maneuver, and criticised on all sides for her instability and improper distribution of weights.

Save her speed trials under circumstances far from service conditions, we have no data on which to judge her efficiency ; but the good results that have obtained in all our new ships augur well for the armored cruiser *New York*. There has naturally been much dis-



UNITED STATES PROTECTED CRUISER "CHICAGO."

[Photograph Copyrighted, 1893, by J. S. Johnston.]



UNITED STATES DYNAMITE CRUISER "VESUVIUS."

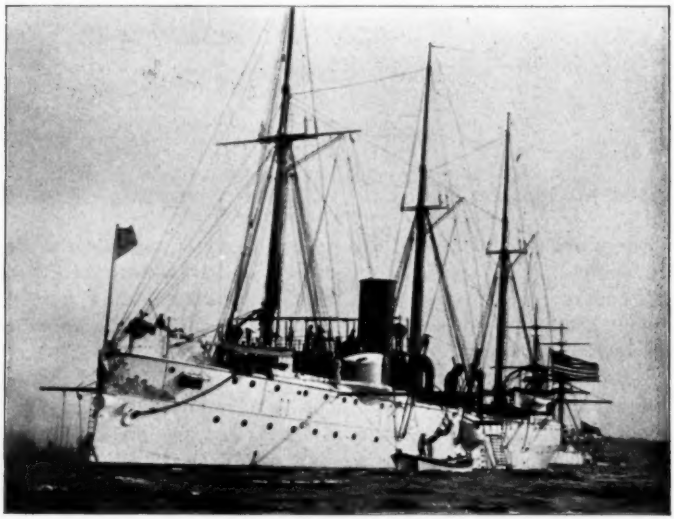
cussion about the details of this splendid cruiser, particularly the reduction of weight and change of form of her armor protection. Without reviving this discussion, which space will not allow, a word about conning towers and ammunition and communication tube protection is most necessary.

If conning-towers are to be of any service, and if commanding officers are to be expected to remain in them during an engagement, they must be made larger and heavier; and marked attention must be paid to the fitting and use of thick hollow forged tubes for communication and ammunition service. This is even more important, if possible, in cruisers than in battle ships and other heavily armored ships, where the thickness of the side, diagonal, barbette, and turret armor afford additional protection. If a 12-inch or a 13-inch projectile should strike any of the conning-towers as at present designed they would probably serve as an escort to the projectile for the remainder of its range, and their inmates would take an involuntary "Trip to Mars."

There was a time when the designs of our ships had to be modified to meet the conditions of domestic supply, but that period has passed, and I am happy to state that our steel-makers can now make anything that the most ambitious naval constructor can handle or the ordnance engineer desire. The *New York* is accepted

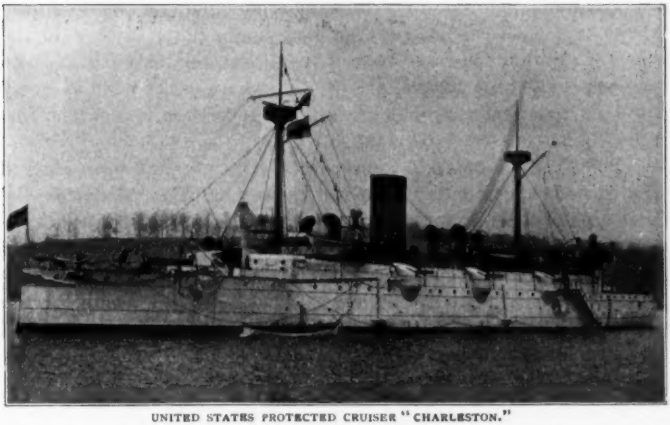
by the United States authorities as the most advanced type of a protected cruiser, and this acceptance has been more or less endorsed by recognized authorities all over the world, especially by the commanding officers of the British cruiser *Blake*, from whose general design the *New York* was laid down.

In 1890 the protected cruiser *Blake* was held to have no equal, let alone a peer; yet the United States admired and accepted her and did a little better. Splinter bulkheads will probably be abolished before the majority of our readers learn their purpose; instead of the usual splinter protective deck, second armored decks



UNITED STATES GUNBOAT "YORKTOWN."

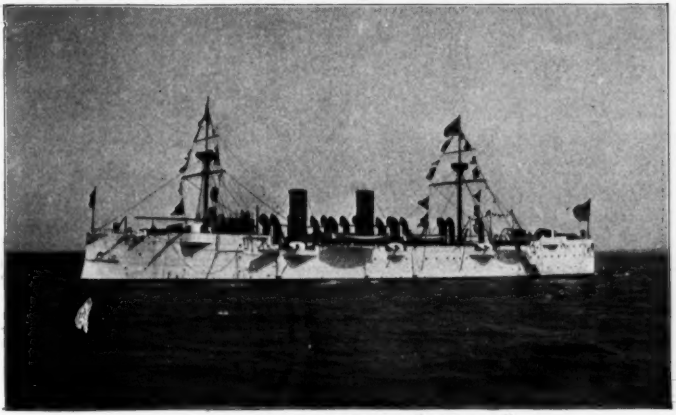
will be provided. These rapid changes are frequently used as arguments for inaction, but they are much less frequent than the returns of hunger that we do not hesitate to satisfy; separated by much greater periods than the seasons for which we provide constantly changing forms and qualities of clothing. But our attention to them is no less important, and the benefits to our industries and people not less useful; as an education, an occupation, a provision for adding to the usefulness and happiness and general benefit of our people; a safeguard and protection against the evils of the wars for which they are designed. Let us hope that these



UNITED STATES PROTECTED CRUISER "CHARLESTON."

splendid engines may not be needed for other than purposes of occupation, education, and discipline; but let the good work go on that we may have some insurance if the fire comes.

The value of the low freeboard coast-defense monitor is still doubted by many, but my own experience in a type much less modern and efficient than those now under construction leads me to accept them as excellent coast-defenders. The work on these monitors has been carried to about 80 per cent. of that necessary to complete them; another year ought to see them in commission.



UNITED STATES PROTECTED CRUISER "BALTIMORE."

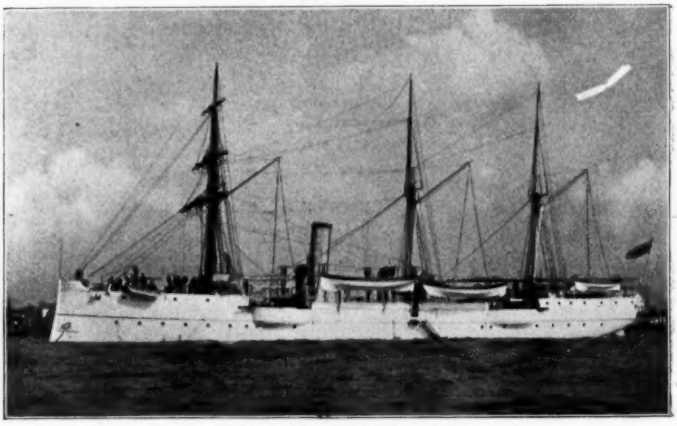
The delivery of 900 tons of heavy armor in one month from the shops of the Bethlehem Iron Company ought to put a stop to the chronic cry that the rapid completion of our remaining unfinished ships is choked for want of armor. This excuse has been as freely used as the once dreaded medical diagnosis *malaria*, which fortunately has ceased to be a fad.

The principal delay in the delivery of armor has been due to the Navy Department's desire for experimentation to decide the best type of steel armor. This has resulted in a most natural expenditure of time, as well as in greatly increasing the cost of the already expensive plants laid down by the manufacturers. Then, too, the demand for cruising vessels has caused the armor for the coast-defense monitors to be put aside to secure the more rapid delivery of that for the armored cruisers and battle-ships of later designs.

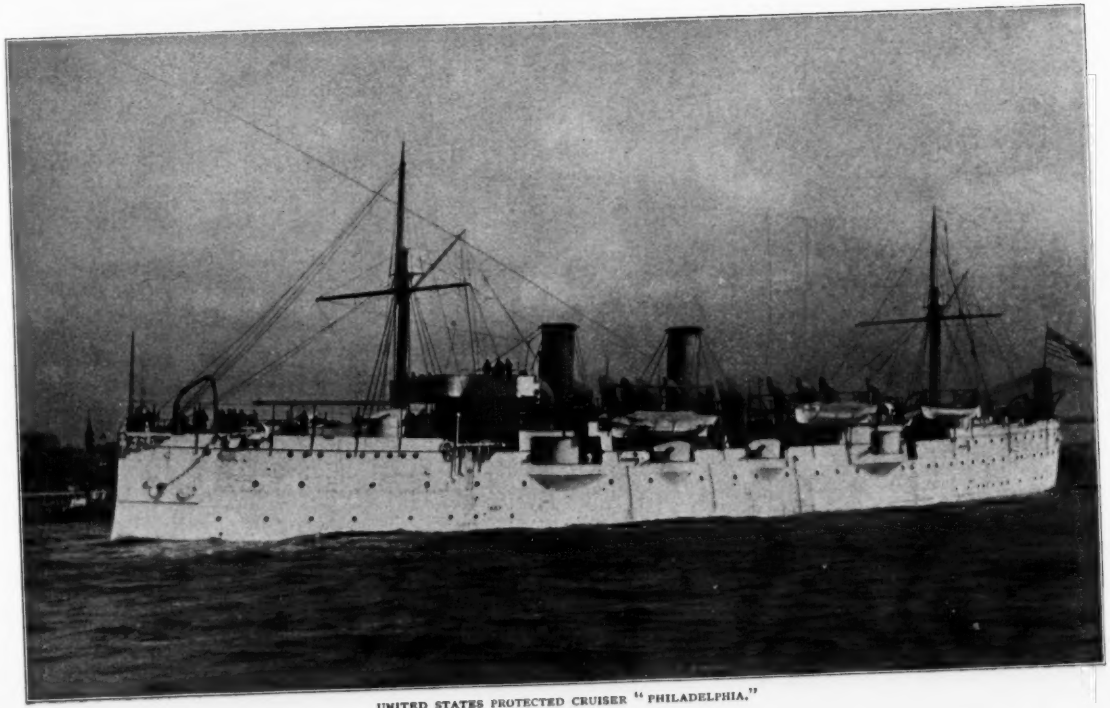
If a decision is reached defining the kind, shape, dimensions, and ballistic tests of the armor, and no alterations are asked after the proposals are issued, and the order for the armor is placed when the contracts for the ships are awarded, there ought to be no delay in their completion for want of armor.

The title "The U. S. Torpedo Boat *Vesuvius*," given to this novel craft in Mr. See's paper,* bids fair to define her future service as a torpedo gunboat, since the many years of experiment

* THE ENGINEERING MAGAZINE, Vol. I., p. 434.

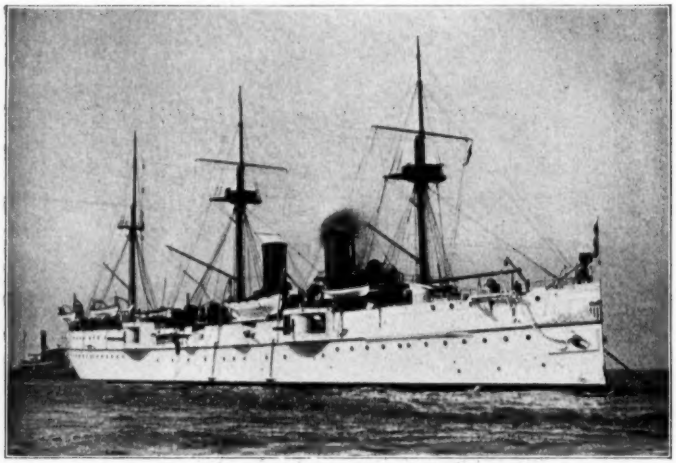


UNITED STATES GUNBOAT "PETREL."



UNITED STATES PROTECTED CRUISER "PHILADELPHIA."

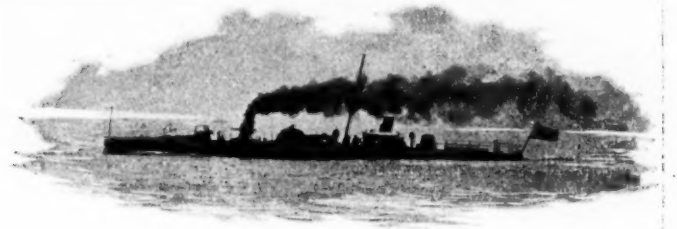
[Photograph Copyrighted, 1893, by J. S. Johnston.]



UNITED STATES PROTECTED CRUISER "SAN FRANCISCO."
[Photograph Copyrighted, 1893, by J. S. Johnston.]

with her dynamite guns have failed to secure confidence in them. Her efficiency as a high-speed gunboat has been proved.

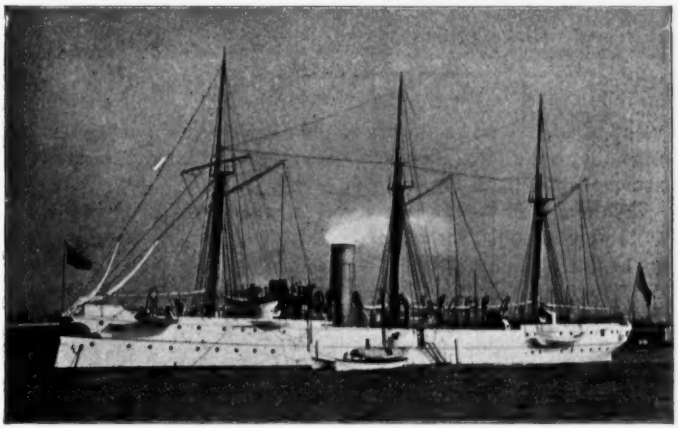
The completion of the harbor-defense ram *Katahdin* is looked forward to with interest as the first of a type designed especially for ramming. Lord Armstrong's recent endorsement of this type will cause it to be looked upon with favor in Great Britain; but his statement that "the strength and stability of the *Camperdown's* prow ram were insufficient to deliver an effective blow without peril to herself," more strongly endorses my views on, and recommendations for, the substitution of the submarine gun, the projectile of which becomes a *detachable ram* reducing to a minimum the dangers attending ramming with a *fixed ram*.



UNITED STATES TORPEDO-BOAT "CUSHING."

The practice cruiser *Bancroft*, although much too small, is such a marked advance in the right direction that perhaps we ought not to make this criticism. Impressed with the scholastic period of the cadet's life, legislation has wiped out the legendary ***Midshipman*** and now follows it with miniature ships for *cadets*. She will at least contain much that is modern and we trust is only a forerunner of other vessels, valuable practical adjuncts of a school in which only the best naval education, discipline, and sense of responsibility can be taught.

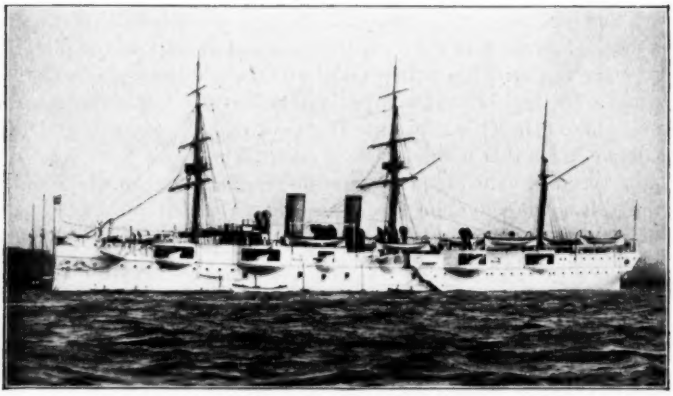
The reports thus far obtained from the ships that have been commissioned contain few adverse criticisms and describe them as useful, comfortable vessels. Our designers and builders can unite



UNITED STATES PROTECTED CRUISER "CONCORD."
[Photograph Copyrighted, 1893, by J. S. Johnston.]

with the Department in congratulation in the possession of war craft of many useful types combining speed, coal capacity, battery power, protection, and service adaptability. Time alone can show whether they are economical.

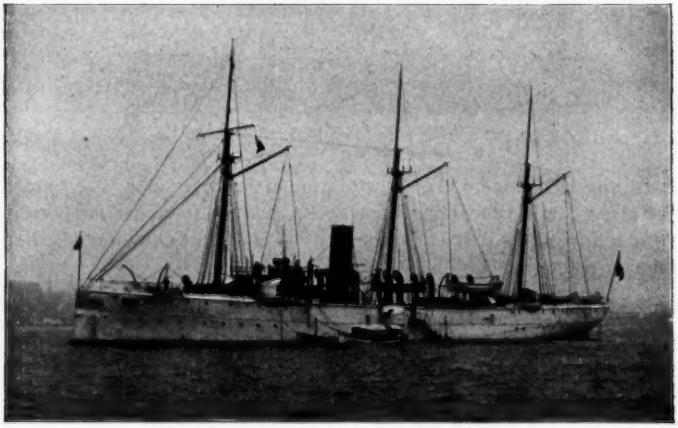
I have purposely omitted illustrations of the wooden steam and sailing vessels which are incurring expenses out of proportion to the service performed; the single-turret monitors that ought to be sorted for sale or transformation into floating batteries, tugs, receiving ships, and the *one* wooden torpedo-boat, the *Stiletto*, which helps to relieve the loneliness of the *Cushing*, our sole steel representative of a type of which we should have hundreds if they are of any



UNITED STATES NAVY—"NEWARK."
[Photograph Copyrighted, 1893, by J. S. Johnston.]

value at all. A running mate to the *Cushing* (the *Ericsson*), is being built on the Mississippi river,—a small and tardy tribute to the accomplishments of a great man.

Although in the British naval maneuvers of 1893 better results were obtained with torpedo craft than formerly, there appears to be little doubt that at their highest speeds even the present types will be so shaken to pieces as to make their lives very short.

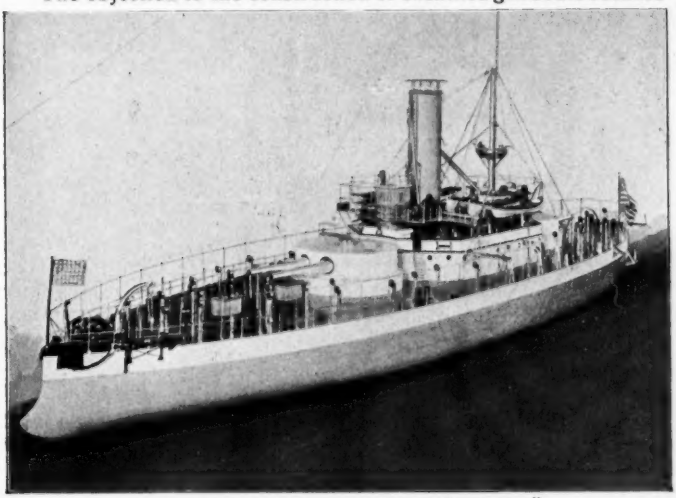


UNITED STATES GUNBOAT "BENNINGTON."
[Photograph Copyrighted, 1893, by J. S. Johnston.]

They are extremely frail; something must be done to make them more efficient.

As regards future construction Congress has provided for three gunboats of 1200 tons displacement, for which bids were opened October 17, and the Navy Department has a small fund available for the purchase of a submarine and two third-rate torpedo-boats. These will go but an infinitesimal way toward utilizing the facilities of our many shipbuilding plants, which, by the end of next year, will probably have completed or launched 90 per cent. of the warships that are now in their yards.

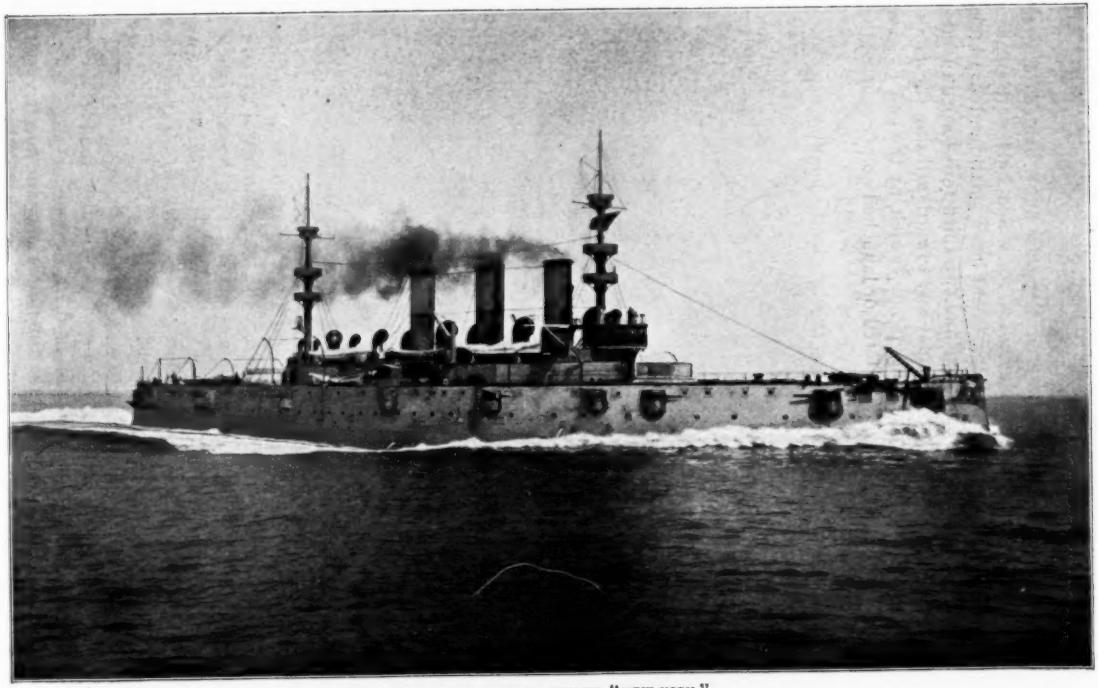
The objection to the construction of sheathed gunboats because



LOW FREEBOARD COAST DEFENSE BARBETTE "MONTEREY."

of a technicality in the act appropriating a certain sum for three steel gunboats is another instance of the inadvisability of Congress deciding the type and dimensions of ships. This decision should be left to the Secretary of the Navy, who should be held as responsible for the success of the program he advises as is the British Premier for his political measures.

The struggle to put more in a ship than she can usefully carry still continues, and doubtless the next move will be to individualize ships and design, construct, and fit them for one or more special purposes. While we are all the time increasing the power, variety, and rapidity of fire of our armaments, we seem to have lost sight

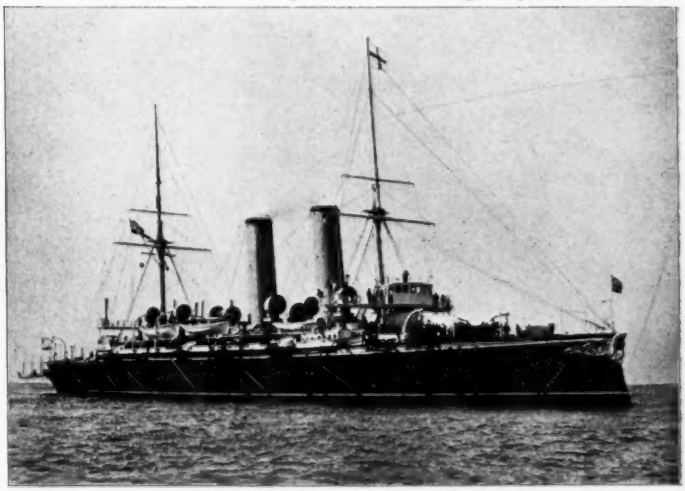


BARBETTE ARMORED CRUISER "NEW YORK."

[Photographed while steaming twenty-one miles an hour on her Official Trial Trip.]

of their ammunition supply. This last is the most difficult problem of the period. We shall probably have to resort to ammunition-supply ships in the manner that coaling vessels accompany blockading squadrons. The difficulty of coaling ships even in the best weather and under fair conditions while engaged in maneuvers warns us of the necessity of having abundant and large chutes conveniently placed for the reception of fuel, for it will probably be a long time before even liquid fuel will be generally used and much longer before power is generated from the element in which the ship floats.

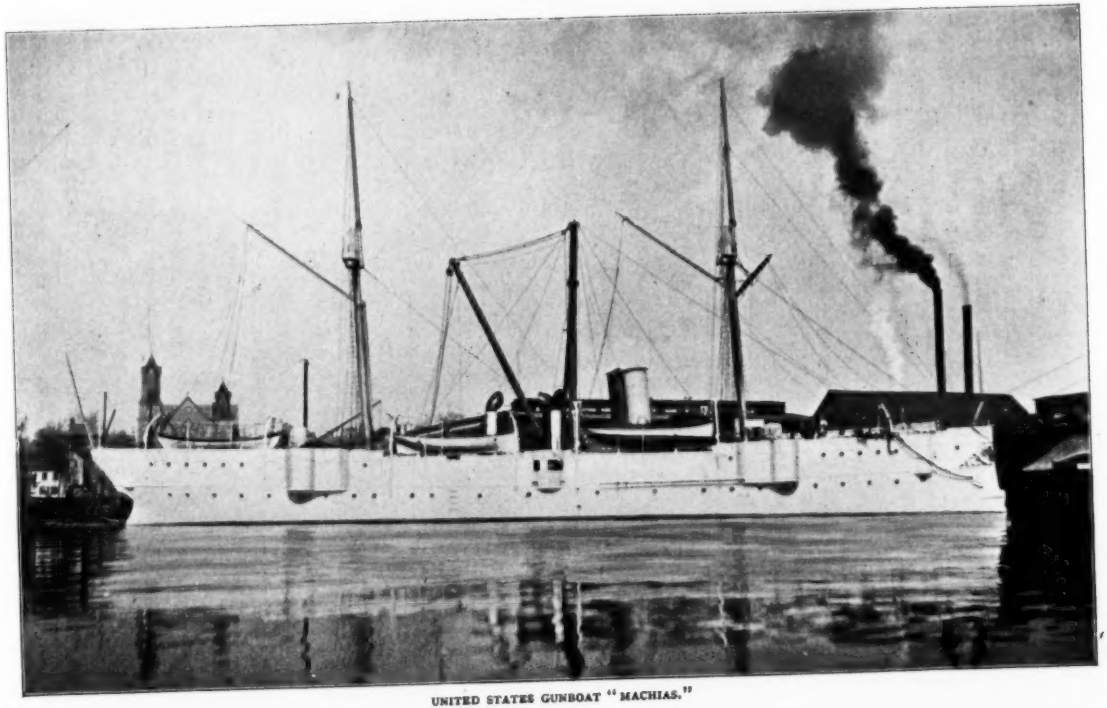
In connection with the question of coaling ships, there is the



THE BRITISH CRUISER "BLAKE."

more vital one, the source of coal-supply for our warships. The possession of suitable coaling-stations has been recommended by many administrations, urged by many secretaries, begged for by naval officers, and by citizens whose interests in foreign territory may require protection, but never more forcibly or comprehensively than by Secretary Chandler in 1883, when the number of our coaling-stations, meager as it was, was in excess of that of a later period.

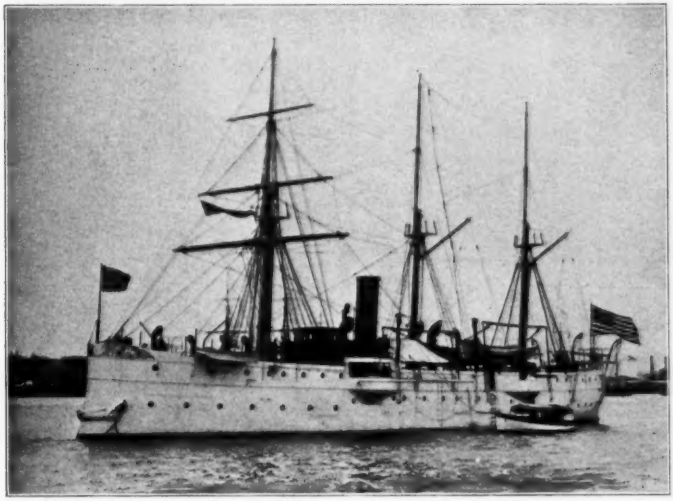
Great Britain has spent enormous sums for the establishment and service of coaling-stations, the Imperial Defense Act of 1888 alone estimating £360,000 ($1,746,000) for coaling stations and £353,851 ($1,716,177) for the erection of barracks thereat.



UNITED STATES GUNBOAT "MACHIAS."

The present year has witnessed prolific inquiry as to our progress in naval architecture and engine-building, and many noted visitors have expressed genuine surprise upon their discovery of our plans, methods of construction, and resources of domestic supply, entitling us once more to a place in the front rank of naval construction. Although largely and wisely based upon foreign experience, this rapid progress must naturally cause anxiety in countries where the capacity of production has already surpassed the demand.

The Bureau chiefs in their reports give in detail the advantages and improvements, the principal among which are: greater speed,

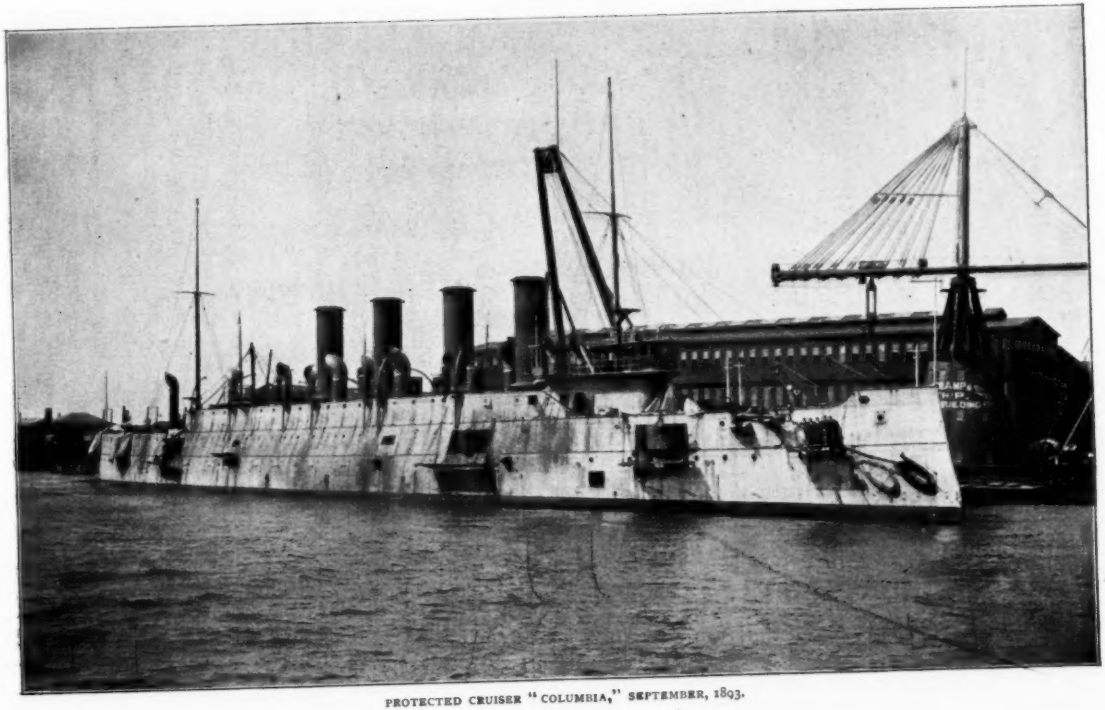


PRACTICE CRUISER "BANCROFT."

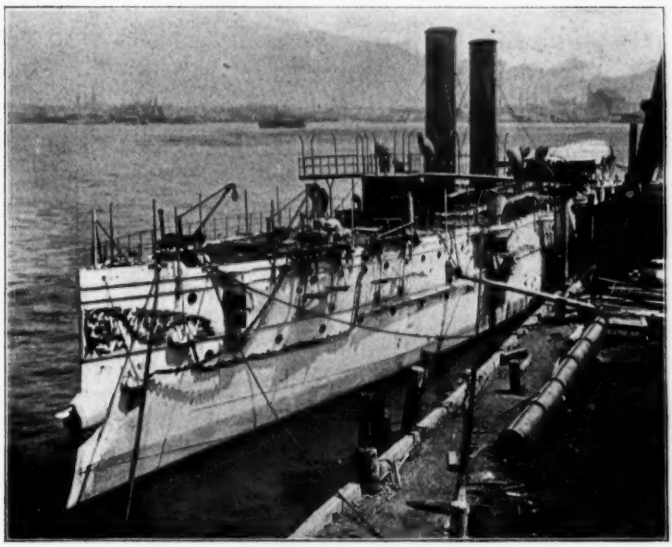
[Photograph Copyrighted, 1893, by J. S. Johnston.]

stronger and better boilers, higher working pressures, increased heating surface and the development of mechanical appliances in the direction of the much-to-be-sought-for qualities of endurance, further development of triple screws and independent triple-expansion engines on the same shaft, or disconnecting cylinders to combine economy in ordinary cruising with power for emergencies.

Great advances have been made and many problems have been solved, but many others yet remain to be solved. The comparative values of liquid fuel, compressed petroleum residue, forced



PROTECTED CRUISER "COLUMBIA," SEPTEMBER, 1893.



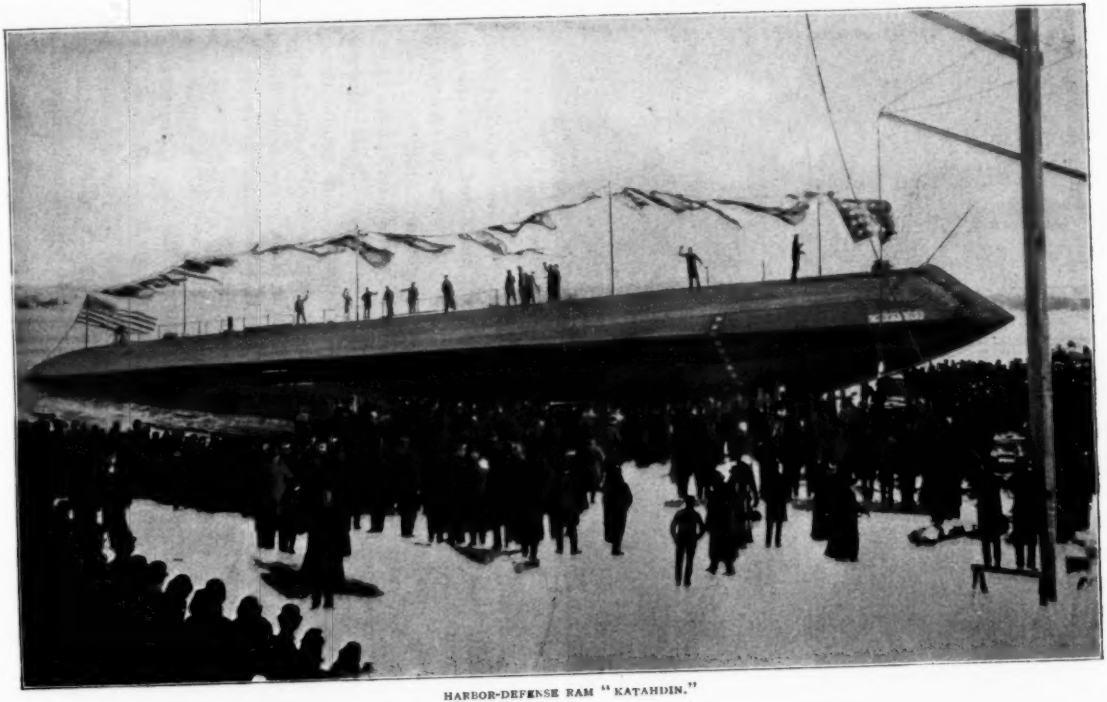
CRUISER "MARBLEHEAD," SEPTEMBER, 1893.

draft and tower smokestacks, triple screws (although fair results with them have been obtained abroad), thick and thin armor protection, long or short, heavy or light, batteries and many other problems are yet surrounded by interrogation points.

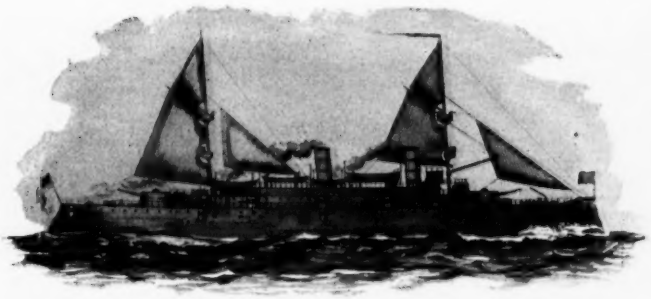
Although the latest designed British warships will have but two screws instead of three, indicating the belief of British designers that more efficiency will thereby be obtained, the combination of economy with emergency power already referred to would appear to be most easily obtained by the three-screw propulsion. Further, Professor Elgar says, "The number of propellers is more likely to be increased in the future than diminished."

Longer stroke in the vertical engine and more comfortable working spaces in the engine-rooms can be easily protected by inclined armored towers without any great sacrifice of other weights. In the boiler-room there is much yet to be hoped for, but with the boiler shells forged in one piece (soon to come), and the control of liquid fuel, the stoker's life will be made much more endurable.

It is a question much disputed among naval architects and



HARBOR-DEFENSE RAM "KATAHDIN."



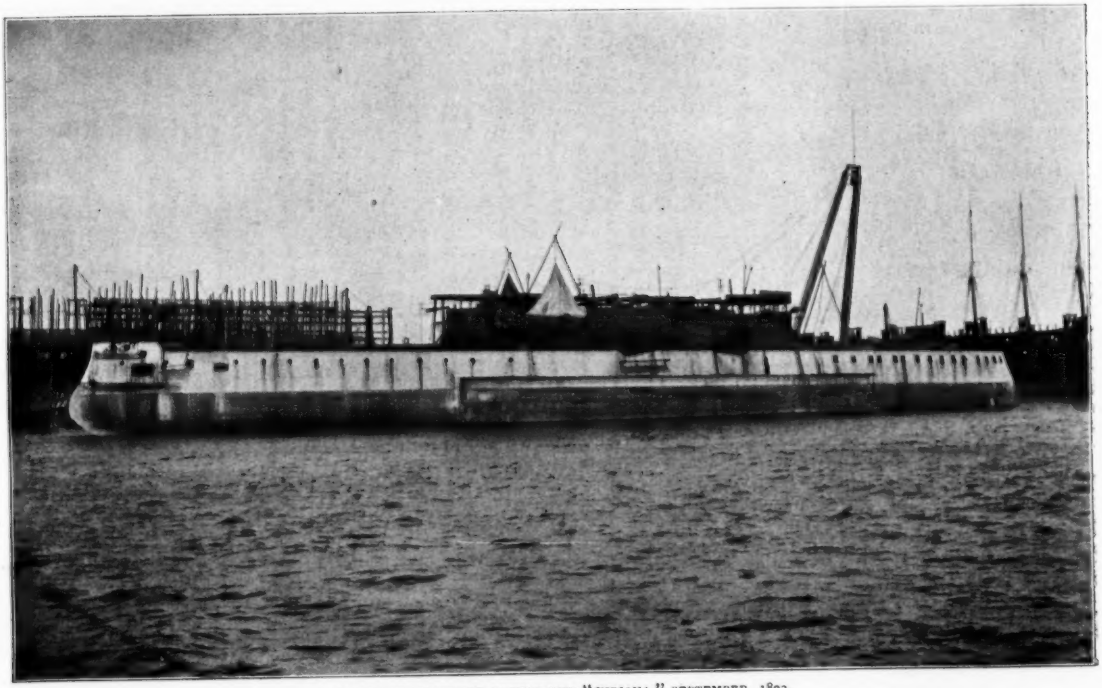
PROTECTED CRUISER "OLYMPIA."

marine engineers whether the incentives thrown out for the highest attainable speeds on acceptance trials constitute a wiser policy than offering higher prices accompanied by service-condition requirements. In many craft, particularly the lighter ones, such as torpedo-boats and catchers, the very light machinery and boilers necessitated by their character are so jarred and strained that their service efficiency is injured in the beginning of their career. We never hear of the successful Atlantic greyhounds having established their records on their trial trips, and yet their service records are most satisfactory. Such severe initial tests of engines do not seem judicious.

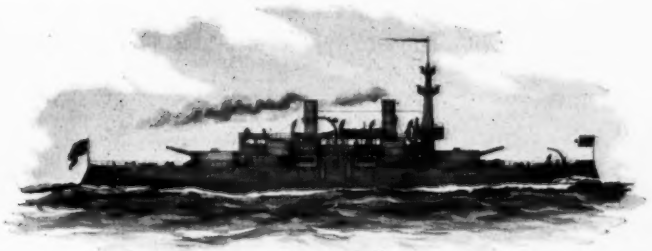
Dr. Francis Elgar, the distinguished British consulting naval architect of the Cunard steamships *Campania* and *Lucania*, in his paper on "Fast Ocean Steamships" read July 11 of this year before the Institution of Naval Architects, said:

> There are various standards by which the speed of ships is judged. We have the trial speeds, which may be determined by a series of runs over a measured mile, or by runs over various distances in smooth water at sea; we have runs for a certain length of time in ordinary weather at sea; and, finally, we have the average speed which a ship can maintain, year after year, over the whole of her voyage in all seas and all weathers. The last is the kind of speed now under consideration.
>
> The best results upon short trials are obtained with large engines and small boilers; but the best results at sea are obtained with smaller engines and large boilers. This is also an instance in which short trials fail as a standard of what can be done upon a long voyage at sea.

The speed considered by Dr. Elgar in this paper would appear to be the most judicious one for comparing the values of vessels at war. A recent writer has remarked: "There is undoubtedly as much in the art of preparing a vessel for her speed trial as in that



COAST-LINE BARBETTE BATTLE SHIP "INDIANA," SEPTEMBER, 1893.

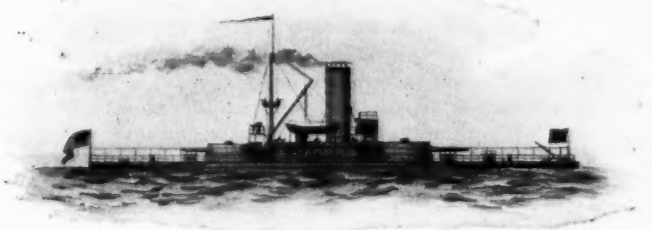


COAST-LINE BARBETTE BATTLE-SHIP "OREGON."

of grooming and caring for a horse that is to enter for a great stake." But how many splendid horses have been sacrificed to break a record!

Forced draft should only be tested to prove its efficient application and not used in the official speed trial. Whether the benefits of discovering all the *unnatural* qualities compensate for the injuries resulting from undue straining of boilers, engines, and hull is a question that perhaps cannot be easily decided.

The recent very successful naval review in New York harbor gave us an opportunity to appreciate our cruisers and gunboats. While the absence of any formidable foreign ships gave them perhaps a higher percentage of value than their due, it must be remembered that our battle-ships now building were also absent, and that our 5 battle-ships, 6 coast-defense monitors, 2 armored cruisers, 13 protected cruisers, 3 cruisers, 8 gunboats, 1 harbor-defense ram, and 1 torpedo-boat, form a very respectable nucleus of what the United States navy ought to be. For comparison with the leading naval powers, a report recently issued by the British Admiralty



LOW FREEBOARD COAST-DEFENSE BARBETTE "MONTEREY."

gives the following estimate of the present naval strength of Great Britain, France, and Germany, considered as the first, second, and third naval powers :

TYPE.	GREAT BRITAIN.				FRANCE.				GERMANY.			
	In Commission.	Reserve.	Building.	Total.	In Commission.	Reserve.	Building.	Total.	In Commission.	Reserve.	Building.	Total.
Battle-ships	24	10	9	43	19	5	8	32	11	3	7	21
Coast-Defense Ships	3	14	19	36	5	3	2	10	...	6	...	6
Cruisers	60	46	22	128	23	20	19	62	14	17	3	34
Others (not Torpedo-boats.)	74	44	...	118	50	62	5	117	19	5	1	25
Torpedo-boats*	...	...	...	186	...	...	...	229	...	...	...	153
Grand total	161	114	50	511	97	90	34	450	44	31	11	239
Annual Expenditure	$89,632,442 60				$51,870,071.00				$23,258,514.50			

*Approximate January 1, 1893.

"If America would keep her own peace with all the nations of the earth, and maintain her place in the vanguard of civilization, she must be at all times prepared for war. This is the lesson of history emphasized by the Rendezvous and the Review." These are the words with which Secretary Herbert closed his "Lesson of the Naval Review" in a recent issue of the *North American Review*. They indicate a liberal policy on his part, and we trust this expression of opinion, probably suggested by the responsibility of his office, will have a beneficial effect not only on those members of the naval committee who have cabinet aspirations, but upon all others who have voice and influence in determining what the appropriations shall be.

BRIDGING THE HUDSON AT NEW YORK.

By Gustav Lindenthal.

THE whole people of the United States and all the nations that trade with us are concerned in the question of a direct railroad entrance into New York city across the North river. Facility and cheapness of transportation into and from this city affect the cost of a large percentage of the whole commerce and travel of the United States. This fact is strikingly illustrated by a comparison of the bank clearings of New York with those of the whole country. They were in 1892 for New York city alone, $36,660,000,000, out of an aggregate for the United States of $62,109,000,000, or nearly 60 per cent. of the total.

The magnificent harbor and the accessibility of the city by water, which have made it the commercial emporium of the country, are, on the other hand, an impediment to inland transportation. New York is separated by the Hudson or North river from the American continent, to the south and west, almost to a degree of isolation. No other city in the world has such a peculiar location. Here is a great seaport, with an aggregate population and commercial importance second to none in the world, separated by a wide and deep river from all the rail transportation systems of the country, with but one exception,—the New York Central railroad, extending in a northerly direction. Thirteen railroads, with thirty-two lines of track to the south and west, stop at the New Jersey shore, opposite New York, which they can reach only by ferries and floats. The number of ferry passengers from the railroads, and from the local New Jersey population residing opposite New York, exceeds now 85 millions per year, and both the passenger and the freight traffic are growing at a rate which in less than fifteen years will double it.

Almost all the New York landings for these ferries are at the foot of narrow, filthy streets, in some of the worst-conditioned quarters of the city. During the day these streets are frequently blockaded with an almost impenetrable mass of teams and trucks, through which the landed passengers are obliged to make their way. In warm weather the air is filled with the pestilential odors from numerous sewers, terminating near the ferry landings. In

winter the passage across the river is made dangerous by ice, fog, and collisions. It frequently happens that the ferry boats lose their way in the fog, requiring hours to find their slips.

Numerous schemes have been brought forward for either tunneling or bridging the North river. The first of which there is any record was by Thomas Pope, an ingenious and ambitious shipwright, living in New York eighty years ago. His scheme was for a single span arch bridge of wood, of which he published a plan and a description in quaint verse. But, like his plan and model for a similar bridge over the East river, it remained a curiosity. There was then no need for either bridge. Railroads and steamers were as yet unknown.

Over fifty years later (in 1867) when John A. Roebling made the plans for the existing Brooklyn bridge, he also made plans for a railroad suspension bridge over the North river; but nothing came of it. The public demand was then great, but the capital could not be obtained. Thereafter bridge and tunnel schemes followed one another in more rapid succession. There are now before one of the principal railroads concerned not less than eight plans and propositions from as many different chartered companies,—four bridge projects and four tunnel projects,—and more will probably follow. One of the tunnel projects was actually started in 1874. After a delay of five years by litigation, work again commenced in 1879. Of two tunnels, only two-thirds of the river portion of one tunnel has so far been built. It represents about one-fifth of the work intended, and its completion no one can foretell.

The failure, therefore, to construct a safer and more convenient crossing than by ferry is not the result of a lack of plans. Companies willing to build bridges and tunnels have blossomed and faded; the difficulties are great, and not generally appreciated or understood.

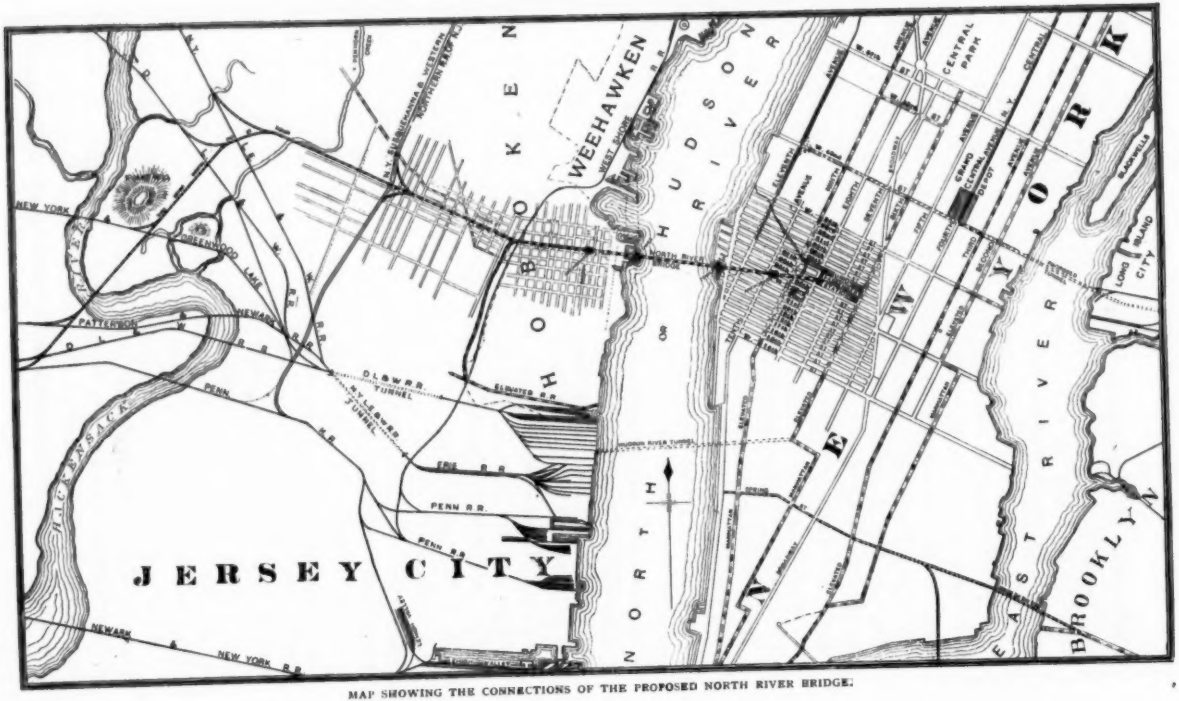
One of the questions naturally arises, Why do not the railroads in New Jersey themselves build, or aid others in building, a direct entrance into New York? From some knowledge of the subject, the writer will point out a few facts.

As long as the railroads in New Jersey are, all alike, obliged to use ferries and floats for crossing the North river, and no one railroad has any advantage in this respect over another, they will be satisfied with the existing order of things. The inconvenience is not felt so much by the railroad companies themselves as by their New York passengers. But the passenger traffic yields only the

smaller, and with several the very much smaller, proportion of their revenues. By far the largest income and profit come from their freight traffic, as is the case with most railroads. A large amount of the freight for New York harbor never reaches the city at all,—namely, that tonnage transferred at tide water of New Jersey, Staten Island, and Long Island, from car to ship or vice versa, whether for trans-oceanic or coastwise trade. Moreover, the freight for or from New York and Brooklyn is carried on car floats to a large number of freight piers, equivalent to freight stations, along the river front of both cities. This method has proved so elastic, convenient, and comparatively cheap for most classes of freight, that neither bridge nor tunnel, with an elaborate system of tracks along the river fronts, would be an adequate substitute for it, nor would it offer any improvement or economy. The supremacy of New York as a seaport is owing, in a great measure, to the facility with which all these railroads can deliver and receive their freight at the nearest points of destination or origin in the two cities,—along a water front of over fifty miles in extent, accessible to all alike, and within three-quarters of an hour transfer distance from their tracks in New Jersey. Fog and ice on the river, although an impediment to passenger traffic, do not seriously interfere with freight traffic, which is merely delayed, but not much more so than elsewhere on their lines. The railroads have well-equipped plants of tugs, lighters, and car floats, and all their freight yards are arranged for this service.

It is their passengers who call loudest for a direct entrance into New York. But here it will be well to bear in mind that the railroads receive from the bulk of their passengers,—namely, from suburban travel—little more than one-half cent per mile, including ferriage to New York. While they receive from other than commuter passengers two and three cents per mile, their number is smaller, and the long distance passengers are the least numerous. For instance: the number of passengers from New York to Chicago, or vice versa, before the World's Fair travel commenced, averaged 180 per day (including the free travel) on the seven roads competing for through passenger travel.

Would a bridge or tunnel increase the number of passengers from Chicago, Washington, or other distant cities? Probably it would; but the increase from these alone would hardly pay more than a small fraction of simply the taxes on a New York terminus. In this respect it would not appear that the railroads in New Jersey



MAP SHOWING THE CONNECTIONS OF THE PROPOSED NORTH RIVER BRIDGE.

had lost much up to the present time by not running directly into New York, no matter what their passengers may endure or think.

These railroads have in recent years erected large and commodious passenger stations on the water front opposite New York. They have greatly improved their ferry service, and now run the largest and finest ferry boats in existence. But the railroads cannot improve the low river neighborhoods of New York, or the filthy and encumbered streets through which their passengers must reach the ferries. This is in great contrast with the railroad stations of less important cities on their own lines. But in none of them, nor in any other large city on this continent, is the cost of an adequate railroad terminus so great as in New York. It is too great to be assumed singly by any one of the railroad companies concerned. There is not enough to be gained by any one road for the financial burden involved. Their combined action for creating or financially aiding such an improvement is even less probable, if not altogether out of the question. All of them are obliged to husband their resources for much more needed improvements and additions along their own lines and in other cities. The difference in their financial conditions is great. Some of the companies enjoy high financial credit and others do not. The former not unnaturally decline to be financially interested in an undertaking in which the latter could claim, after completion, equal benefits with them under the existing laws, without having assumed, or being able to assume, their proportionate share of the financial burden and responsibility for construction. The work is beyond the usual character, in risk, time, and cost; besides, there is among them great rivalry of business interests. Moreover the railroads see no advantage in entering into traffic-contracts, contingent on future conditions and events, not in their control, and that may come to plague and entangle them in some unforeseen manner.

No one road would or could relinquish its present methods, and send its entire business for New York over a bridge or through a tunnel. The railroads would send only such business as may result advantageously to them. Under such conditions they would however readily avail themselves of a direct entrance into New York, alike accessible to all, provided a separate company independent of them would build it. This is the only way to its realization, and for it large capital is indispensable. If the undertaking end with a floating debt,—so frequently the case with new enterprises,—it would be sure to terminate in loss to the investors. Numerous

instances of this character can be quoted. Railroads can wait and use the ferries, while interest on bonds is coming due and defaulted, with the usual disastrous results.

Leaving this question, we turn to another: which is preferable, a tunnel or a bridge? It can be best answered from the following considerations.

Prompt and efficient first-class service requires that the passenger trains should come into New York at high speed and *en bloc*,—*i. e.*, without change of engines or crews in New Jersey,—just as the trains of the New York Central come into the Grand Central station at Forty-second street without change of engines in Harlem. High speed is a matter of course over a well-constructed bridge, but not so through submarine tunnels, resting in the mud foundation of the North river. Locomotives and trains through them would have to move slowly. The difference in the volume of traffic transported through one and the other is similar to the difference in the volume of water discharged through a pipe at fast and slow velocities. A bridge track has greater capacity for traffic volume than a submarine tunnel track. Careful estimates show that a multiple track bridge, with corresponding terminals, will cost very much less than an equivalent tunnel arrangement, and can be constructed in a much shorter time.

A bridge will not interfere with the streets. The approaches and station can be on a high level above them, similar to the arrangement of the Pennsylvania railroad station in Philadelphia. Short connections can readily be made with the existing railroads in New York, and through them with the entire railroad system of New England.

The heavy grades of tunnels necessary for diving 100 feet or more under the river; the large, continuous, and unavoidable expense for pumping, lighting, and ventilating; the greater risk to human life in case of wrecks; the well-known aversion of mankind to submarine, chilly, and damp passages; the incessant roar; and other causes,—declare against tunnels for heavy railroad trains with locomotives. A change to smokeless motors for the tunnel would involve greater expense and loss of time.

Furthermore, tunnel terminal stations cannot be very well elevated above the street; and they cannot be on the surface of the ground, because there would then be grade crossings with the intersecting streets, and such would not be permitted any longer in New York city. Those now existing may in time be abolished.

Tunnel terminals, therefore, must be under ground and under the streets. We know from the London example what this means: dark, dingy, damp, and unhealthy quarters, full of smoke and noise; dirt and soot everywhere; the passengers glad to get into the fresh air and daylight.

Submarine work is the most uncertain in cost and time, and there is no record of a submarine tunnel for railroad purposes earning current interest on its cost.

It is probable, however, that submarine tunnels under the North River may come into use for local travel and rapid transit, by means of cable or electric motors, between the lower part of New York and Jersey City. The present ferry facilities may in time be supplemented for local travel by such tunnels. The Hudson river tunnel, mentioned above, and now for nineteen years under construction, would be suitable for such purpose, if completed. Another such tunnel, through the deep rock under the river, is proposed on a line from Montgomery street in Jersey City to lower New York, and thence to Brooklyn. Such tunnels would require no special ventilation, and could be kept clean and well-lighted.

But for heavy railroad trains, and for fast service, the locomotive will remain for a long time to come the cheapest motor we know of, and for such railroads a bridge is the most favored and best way for getting into New York.

A bridge, centrally located with regard to all the railroads on the New Jersey side and with regard to the business section of lower New York, would command about one-half of their passenger business, together with all the freight business for which it would be a time and money saving route,—namely, perishable and fast freight, food products, merchandise and high-class freight, storage and warehouse freight, and express goods whether for or from New York or New England. Such a bridge, accessible to Jersey City and Hoboken with their rapidly increasing population, and with their expanding system of electrical traction roads, would also have a large local traffic,—more than enough to make up for that number of the railroad passengers who would continue to use the ferries.

That, under these conditions, the passenger traffic would rapidly increase could be confidently expected from the experience with the Brooklyn bridge. One year after the completion of that bridge, in 1884, the number of passengers was 8,528,000, while in 1892 the number was over 43,000,000,—or in eight years five times

greater,—and it is steadily growing. The Brooklyn bridge accommodates merely local traffic; no railroads are using it. For a North river bridge, centrally located, a much larger passenger traffic could be expected, with a growth proportionately as fast as on the Brooklyn bridge.

The growth of traffic on the elevated railroads of New York is another instance. It is phenomenal, and the rapidity of it was unforeseen. In 1880 there were transported 60,830,000 passengers, and in 1892, with the same length of road, over 213,000,000 passengers; and the traffic is still on the increase.

Other instances of the enormous growth of the transportation business in and around New York city could be cited to illustrate the necessity of providing, not only for the business now apparent, but for the rapid growth certain to result from increased comfort and facilities of transportation.

It must not be overlooked, however, that that rapid growth of traffic was greatly stimulated by low fares,—three cents over the Brooklyn bridge and five cents over the elevated railroads.

The Brooklyn bridge is only one mile long. Most passengers over it use the elevated railroads at either end, thus paying really eight cents for any trip over one mile and up to eight miles long. The average length of a trip is probably under four miles, including the bridge; and the rate per passenger mile would therefore be over two cents. This is a much higher rate per mile than the New Jersey railroads receive for suburban traffic, which would be the kind most increased by the bridge. From this it will be plain that the fares over the North river bridge will have to be low, and that the largest possible amount of local travel, which is independent of the railroads, and relatively the more profitable, must be aimed at for helping to earn interest on the invested capital. How important this consideration is will appear from the fact that the local passengers from Jersey City and Hoboken number at present forty-one million, against forty-four million railroad passengers annually. One-half of all those passengers would save from five to thirty five minutes time by a bridge directly into the business heart of New York.

The principal advantage to the railroads would be from the growth of population and business along their lines in the vicinity of New York, stimulated by the superior accommodations of a terminus in New York and an unbroken rail connection to all parts of the United States, and from the saving of time. This service

would be worth a reasonable charge ; but, competing with ferries or tunnels, and with a cheap system of collecting and delivering freight, the tolls would have to be adjusted for a large business at low rates ; otherwise the investment would not pay.

Space does not admit of discussing at length the questions of estimated cost and estimated revenues, or of the engineering features of such a work. They have all been carefully considered, and conservative estimates made by experienced railroad managers show, that the terminals in New York, large enough for all the railroads, would have to accommodate 2000 trains every twenty-four hours. This number may be exceeded in a few years after completion of bridge, from the resulting enormous stimulation of traffic. The existing thirty-two tracks from these railroads can be readily converged into six tracks on the bridge ; namely, two for suburban passenger trains, two for through passenger trains, and two for freight. To this would be added two tracks for electrical cars, or eight tracks in all from the beginning. An enormous saving in capital can be effected by building the eight tracks on one structure ; because its cost would be only 60 per cent. of the cost of four separate double track structures, other things being equal. The bridge itself is the least costly part of the undertaking. Its cost represents only a fraction—about one-fourth —of the cost of the undertaking in its entirety. In the case of the Brooklyn bridge, for instance, which has no terminals to speak of, the cost of the bridge structure proper was only one-third of the expenditure for the entire work.

The principal items of expense for an entrance into New York city will always be for the terminals, for damages, and for the costly right of way, although this expense can be economized for a bridge by arranging the tracks, if necessary, on two platforms, one above the other, limiting the land to be acquired to the smallest practicable dimensions.

The revenues from traffic are estimated at low rates : from five cents upward per trip for passengers, and correspondingly low for freights, the aim being to offer the railroads on both sides of the river a distinct advantage over present methods. The traffic revenue would be supplemented by a large income from the real estate which must be acquired for terminals. It would seem business folly to use such costly land merely for railroad tracks, when every foot above and below the tracks can be made to earn a profit from improvements built thereon, the cost of which has been included

in the estimated total cost of the undertaking. The storage and warehouses and freight depots, built above and below the tracks, *and connected with them*, would save to the merchants and shippers of New York large sums for trucking and hauling freight through the streets. The rentals from them would be independent of the bridge tolls, which could therefore be made so low as to readily compete with ferries and tunnels. The total revenue from the whole undertaking, for the business in sight and without allowance for stimulated growth, promises from the beginning a very ample return on the invested capital, with careful management.

The tendency of railroad rates is still downward, and the bridge tolls would follow suit. This tendency has resulted in thrift and economies in the construction and management of such large properties, to an extent and in details not dreamed of twenty years ago. Closest management and thorough knowledge of the business are now essential to the success of such undertakings.

The fatal mistake is sometimes made, either wilfully or negligently, of underestimating the cost of a large work, to make it appear cheap and to attract capital. It has never yet resulted otherwise than in financial collapse and loss to investors. Delays from litigation and from periods of business depression are sometimes unavoidable and costly, and should be amply allowed for.

The successful financing and management of such a large work, with private capital, presents a formidable task, requiring the highest ability ; and all other difficulties, be they legal, engineering, or otherwise, are subordinate to it. The managers must needs have their enthusiasm tempered with prudence and foresight. There is, to-day, an abundance of engineering skill and constructing facilities for any great work, and with sufficient capital anything can be built.

A bridge over the North river, in spite of every difficulty, is not only feasible on the lines indicated, but, as the writer has good reasons for believing, will be realized in the not distant future.

THE INVENTOR OF GAS-LIGHTING.

By William Fletcher.

AMID the bustle and confusion of these high-pressure times, we, who are reaping the innumerable benefits which have been dearly bought and handed down to us by our predecessors, seldom stop to think of those who have rendered such services in the past. Yet there are hundreds of souls who have lived and labored, leaving the works of a useful career as their eternal legacy, whose biographies can never be written ; and the names even of these worthies will never be known. Such has been the fate of men who have lived in the past, and such is likely to be the lot of many who are living at the present time. Among those who are doing the greatest service, and in return receive the smallest amount of recognition, we think the faithful assistants of our great engineers claim a place. Some writer has said : " Many engineers owe their reputation to the unacknowledged skill of the assistants whom they had the good fortune to enlist."

The name of James Watt has been honored without limit, which has our approval, but we must bear in mind that Watt was always surrounded with clever assistants, and we believe that very much of the fame and wealth that fell to his lot was largely owing to the excellent coadjutors who rendered energetic and valuable services during the whole of his business career. The foremost place in that honorable rank we must assign to William Murdock, who for upwards of half a century was Watt's most skillful and esteemed assistant. Watt has had numerous biographers ; Murdock has not one. He is one of the many patriarchs of mechanical engineering whose services have never been adequately recognized. Not only is Murdock's ingenuity nowadays rarely mentioned in connection with Watt's career, but some of this clever assistant's inventions have recently been erroneously attributed to Watt.

In order to celebrate the centenary of the invention of gas-lighting, and to help in some measure to place W. Murdock in his true position among the illustrious inventors and engineers of the past, we may make a rapid survey of his leading inventions, allowing his experiments in gas-lighting to claim our chief attention. It has often been predicted that this system of illumination is doomed to give place to its more brilliant rival, the electric light, but

in spite of these prophesies gas-lighting appears to be holding its own; while the manufacture of coal-gas is certainly on the increase, owing to its almost universal adoption for cooking and household heating purposes, to say nothing of the enormous consumption of gas by the thousands of gas-engines that are used for all manner of industries.

William Murdock was born at Bellow Mill, near Old Cumnock, Ayrshire, Scotland, in 1754. His father carried on the business of miller and millwright, and also occupied a farm on the estate of the Boswell family of Auchinleck, by whom he was much esteemed for his integrity and ingenuity.

During Murdock's earliest years he worked with his father, under whose tuition he quickly obtained a considerable amount of technical knowledge, and gained a reputation for intelligence and skill of no ordinary kind. The father and son between them constructed a wooden horse, worked by mechanical power, on which young Murdock traveled about for miles around the neighborhood of his native place, to the amazement of the inhabitants. Before Murdock was twenty years of age he designed and erected a handsome bridge over the river Nith, in Dumfriesshire, which still exists. As he was anxious to improve his position, and to become something more than a country mason and mechanic, he left Scotland in 1777 with the intention of seeking work from Boulton & Watt, at Soho. Upon his arrival in Birmingham he obtained an interview with Wm. Boulton, who gave him no encouragement, telling him they had no vacancy, as trade was slack. As Boulton was bidding the shabbily-dressed and foot-sore millwright good speed to some other shop he was struck with the peculiar appearance of the hat Murdock wore, and suddenly called him back and asked what it was made of.

"Timmer, sir," said Murdock, modestly.

"Do you mean to say it is made of wood?"

"Deed it is, sir."

"How was it made?"

"I just turned it in the lathie."

"But it is oval, man, and the lathe turns things round."

"Aweel! I just gar'd the lathie anither gait to please me, and made me one."

This was sufficient proof that Murdock was a mechanic of no mean skill. He was put upon a trial job in the Soho works, and quickly displayed his capabilities as a workman, which led to his engage-

ment for two years at the rate of fifteen shilling a week. He commenced as an ordinary workman, but his diligence, sobriety, and skill soon led to his promotion, and it was not long before he became Boulton & Watt's most trusted co-worker and adviser in all their important mechanical undertakings. When Murdock entered the Soho firm Watt was well-nigh overwhelmed with the difficulties of getting his steam pumping-engines into practical use; the worry and the vexations of the breakdowns in the machinery, Watt said, "would soon knock him up altogether." Murdock was appointed to superintend the erection and undertake the general charge of their engines in Cornwall, and he quickly overcame the difficulties that were more than Watt could manage.

Murdock traveled from mine to mine and often worked for long periods without rest and little food. His devotion to the work pleased Watt; his open countenance and friendly disposition, combined with his anxiety to please, soon made him very popular with the mine-owners. Notwithstanding the long hours and incessant night work, occasioned by the superintendence of the engines under his charge, he found time to construct the beautifully simple model locomotive that we are so familiar with, which doubtless was the first successful road engine ever made in England. Watt had often talked of making a steam-carriage, which would have been an abortion, with its condensing apparatus, wooden boiler, and sun-and-planet motion. Murdock, with rare ability, discarded these cumbersome details, and produced the high-pressure engine. The first experiment was made in Murdock's house at Redruth in 1784, when the little model hauled a wagon around the room, the single wheel, placed in front of the engine, fixed in such a position as to enable it to run in a circle. The model had been continually in the possession of the Murdock family when, in 1833, it was purchased by Messrs. Richard and George Tangye. It is now in the Birmingham Art Gallery, and is still in good working order, although over one hundred years old, and when under steam is capable of attaining a speed of six to eight miles an hour.* This little carriage was made with Murdock's own hands, which makes it exceedingly interesting to engineers.

In the year of 1798, Murdock returned to take up his permanent residence at Soho. "His energies to further the interest and celebrity of this establishment were not used in vain, for they assisted, in no slight degree, in procuring for it a name celebrated

*"One and All," by Richard Tangye.

throughout the civilized world. His time there was so completely occupied by his mechanical pursuits that he devoted no time to recreation. The rising sun often found him, after a night passed in incessant labor, still at the anvil or lathe, for with his own hands he would make those articles he could not trust to unskilled ones." Among his inventions we may enumerate the following: (1) An apparatus for boring cylinders; (2) a new method of forming steam-jacketed cylinders; (3) the sun and-planet motion used on Watt's engines for procuring a continued rotative motion from a reciprocating engine, without the intervention of a crank; (4) the double D slide-valve and other valves used on Watt's engines; (5) a rotary engine, one of which continued in use for thirty years and worked well; (6) the locomotive engine already referred to; (7) a patented method of boring stone pipes for water; (8) a lift worked by compressed air; (9) the cast-iron cement so extensively used in the old days; (10) the oscillating engine.

Murdock is still better known to the public, and most deservedly so, by his invention of applying the light of gas from coal to economic uses. For the first experiment Murdock procured a kettle, which he placed on a fire in his workshop, after filling it with small coal. The spout of the kettle had a perforated thimble on the end, through which the gas issued, giving a good flame when lighted. Many experiments on a larger scale were carried out, and eventually Murdock's house and offices, at Redruth, were lighted with coal-gas, made in an iron retort and conveyed in pipes to the different rooms of his house, where it was burned at proper apertures or burners. This appears to have been the first application of gas for useful purposes, although the gas had been discovered and obtained both naturally and artificially more than half a century before. "Murdock had a gas-lantern in regular use, for the purpose of lighting himself home at night across the moors from the mining engines that he was erecting, to his house at Redruth. The lantern was formed by filling a bladder with gas, and fixing a jet to the mouthpiece of the bladder, which was attached to the bottom of a glass lantern, with the bladder hanging underneath. After various experiments, by which he proved the economy and convenience of the light so obtained, compared with that from oils, resinous, or animal substances, he perfected his apparatus, and made a public exhibition of it, by lighting up the front of Boulton & Watt's works, at Soho, on the occasion of the general illumination for the peace of Amiens, in 1802." This

brilliant illumination was received with immense enthusiasm. Watt would have nothing to do with any patents relating to gas, hence Murdock derived no advantage from the extended use of the new system of lighting beyond the honor of having invented it. Two large cotton-mills in Manchester were fitted up with gas in 1805, and another mill in Leeds soon afterwards. It became necessary to enlarge the Soho works to make room for the manufacture of the gas-making apparatus. Murdock published a paper describing the advantages of the new light in 1808, for which the Royal Society presented him with their large Rumford gold medal. The retort first employed by Murdock was made of cast-iron of a cylindrical form, placed vertically in a common portable furnace. The inconvenience of removing the coke from the vertical retort led to the adoption of a horizontal cylinder. These retorts were also made of cast-iron, from 12 to 20 inches diameter, and from 3 to 7 feet in length. The form of retorts used at the cotton-mills of Messrs. Phillip & Lees was similar to that first mentioned, but larger in size, and a cage was adopted to facilitate the discharge of the coke; this cage was let down into the retort previously to charging it with coal, and was afterwards lifted out by means of a small crane, when the process of distillation was completed, bringing out with it the whole of the coke. Murdock tried a retort having an opening at each end, but this was found to cost more, and he adhered ultimately to the simple horizontal retort, which came into general use, and continued so, with little alteration in principle up to recent times.

As soon as it was proposed to light the streets with the new method, the idea was ridiculed by Sir Humphry Davy, who asked if the dome of St. Paul's would be used as a gasometer! Sir Walter Scott made clever jokes about those who proposed "to send light through the streets in pipes" and to light London "by smoke," though he was glad enough, not long afterwards, to make his house at Abbotsford light and cheerful on wintry nights by the use of that very "smoke." Wollaston, a well-known man of science, declared "that they might as well attempt to light London with a slice from the moon." *

When the House of Commons was first lighted by gas the architect imagined that the gas ran on fire through the pipes, and therefore insisted on the pipes being placed several inches from the wall, for fear of the building taking fire; we are also told that

* "Invention and Industry," Dr. Smiles.

"the members might be observed touching the pipes with their gloved hands, and wondering why they did not feel warm." In 1814 Westminster bridge was first lighted with gas; Glasgow was lighted in 1817, Liverpool and Dublin in 1818, and Birmingham not until 1826. "So completely was Murdock absorbed at all times with the subject in hand, that he was regardless of everything else. When in London explaining the nature of his substitute for isinglass, he occupied very handsome apartments; he, however, little respected the splendor of his drawing-room, and proceeded with his experiments quite unconscious of the mischief he was doing. One morning his landlady, calling in to receive his orders, was horrified to see her magnificent paper-hangings covered with wet fish skins hung up to dry, and he was caught in the act of pinning up a cod's skin to undergo the same process. He and his fish skins were at once thrown out of the house into the street."* During the erection of an apparatus for heating the water for the baths at Leamington, Murdock met with a severe accident; a heavy cast-iron plate fell upon his leg and crushed it; he never completely recovered from the effects of the accident, but as soon as able, he was at work at the Soho factory again.

Although Watt ignored the use of steam as applied to navigation, Murdock and the younger members of the firm took up the question, and devoted themselves to the manufacture of engines for steamboats, with success. Dr. Smiles says: "In the midst of these repeated inventions and experiments, Murdock was becoming an old man; yet he never ceased to take an interest in the works at Soho. At length his faculties experienced a gradual decay, and he died peacefully at his house at Sycamore Hill, on November 13, 1839, in his eighty-fifth year. He was buried near the remains of Boulton and Watt, and a bust by Chantrey served to perpetuate the remembrance of his manly and intelligent countenance."

* "Murdock's Inventions," Buckle.

THE ART OF SUCCESSFUL ADVERTISING.

By Ernest H. Heinrichs.

ADVERTISING has become generally recognized as a necessary and important adjunct to every business, trade, profession, and mercantile or commercial enterprise. The cobbler advertises his handiwork on the window-ledge; the grocer puts his best stock of vegetables on the sidewalk; the clothier, the dry-goods man, and the furniture-dealer fill the pages of the newspapers; the actor seeks to attract the attention of the public in flaming posters, and the manufacturer advertises his specialties in the trade papers and magazines. The time-worn axiom that good goods do not need advertising is now relegated into the deepest recesses of the business man's vault containing memories of the past, and is brought out only to serve as a dampener upon a too persevering advertising solicitor. In this age of keen competition, it is not likely that any man will have a purchaser for his goods simply because they have the characteristic of excellence. He must promulgate their distinctive advantages or their superiority.

To do this successfully, he must advertise. There are as many ways of advertising as there are roads leading to Rome, and the question is how to find the right way.

To the writer it seems that the first point to be considered is, how much money will the capital of the business to be advertised permit to be used for this purpose? This point, once disposed of, will immediately suggest another one,—how may this sum be expended to the best advantage, or, how can the business be advertised most effectually with this stipulated sum?

The thorough study of these points is of the utmost importance. There must be method pursued in the manner of advertising, if it is to be profitable, else there will be absolute failure. One who decides to embark in any enterprise invariably makes it his first business to find out how much it will cost him to make a start. The same principle applies to advertising. It is a business in itself, the management of which requires the greatest care and attention.

Some people say that they give the papers an advertisement occasionally just to get on the good side of them; others, that they give some man from the papers an advertisement, because he is a "jolly, good fellow." In fact, one gentleman remarked to the

writer some time ago that "there is a good deal of sentiment connected with advertising!" Now there is much truth in what this gentleman said, and more is the pity. It is this kind of advertising which is dangerous, inasmuch as it reflects upon advertising as a legitimate business, because it deteriorates to a form of bribery, and it disheartens as well as disgusts both the reputable publisher and the honest advertiser.

Every bona fide publication which sets apart a certain amount of space for advertisements disposes of this space to its customers at a stipulated price, for which price the purchaser of the space has the right to expect a certain return in the shape of orders. It is a business transaction pure and simple,—a contract entered into between the publisher and the advertiser, by which the one expects the price of the advertisement, and the other to increase his business. It is a fair exchange, and that is what every business transaction should be. Such sentimental transactions as have been cited before are unbusinesslike. Advertising contracted for through sentimental reasons may be termed an act of charity, and charity and business are no relations. This sentimental advertising has been the foundation for the establishment of very many publications, and many of them have maintained a precarious existence under these conditions. Fortunately, however, their existence has seldom been a long one.

Having decided how much money may be spent in advertising, the next question is, how and where is it to be done? To settle this question is very difficult, for the reason that the mediums for advertising are legion. Many old advertisers believe that advertising by circular letter affords the surest and best way to reach a customer. They argue that if they send out a stamped envelope with a type-written page or two of matter inside, the recipient will surely read these pages. Then there are others, who are not particular about having the matter even type written; they are satisfied to get up an elegant advertisement, have a printer strike off as many copies as they have customers on their books, and then they send these circulars to their customers. Again, there are those who now and again get up a catalogue, in which are set forth descriptions in general and in detail of everything they sell, and they send these catalogues wherever they hope to catch a probable purchaser. Then there are firms who rely entirely upon their agents and representatives to advertise their goods by word of mouth. Most advertisers, however, consider all these methods auxiliary; they

help a little, but they do not do much good alone. It may be safely asserted that newspapers, magazines, and trade papers, are now recognized as the standard advertising mediums.

The object of advertising is to make certain statements known to the public at large. Hence the more people see the advertisement the more thoroughly does it fulfill its mission. Of course this opinion may be questioned by the advertiser of specialties, who desires to reach a certain class of people only, but this statement is meant to apply to advertising in general, though it would require merely a slight modification to apply to all cases. Nevertheless, one fact, borne out by the most successful advertisers in America and in Europe, is that what is broadly understood by newspaper advertising is the best and cheapest advertising that can be had. The term "newspaper" includes of course periodicals of every class.

In choosing a publication some people have very peculiar ideas; if they see a paper with a large number of advertising pages, they take it for granted that an advertisement in such a paper means money thrown away, because the advertisement will be crowded out of sight. This is a mistake. The best papers, as a rule, have the largest amount of advertising; hence they must be the best advertising mediums. The best papers are apt to be the most widely read, so that advertisements in them must of necessity become widely circulated, which is the great object of advertising. To this reasoning it may be replied that it does not follow, that, because an advertisement is circulated among ten thousand people, ten thousand people will read it. Certainly not, but an advertisement circulated among ten thousand people stands a better chance of being read ten thousand times than an advertisement circulated among only five thousand people. Apart from this deduction of simple logic it must not be forgotten that advertisements are read with as much interest as any other portion of a newspaper. This may not always have been so, but it is nevertheless true to-day. It may be that the busy man will carelessly pass over the advertising columns of the daily newspaper, but the housewife will read them twice and thus make up for his neglect. But take the popular magazines of to-day, the advertising pages of which are truly remarkable, not alone in their appearance, but also as regards their contents. Does any one dare to assert that an advertisement placed anywhere in these pages is a lost investment? The advertising pages of these periodicals represent from month to month the

most striking reflection of the commercial, the industrial, and the financial, as well as the intellectual, progress of this country, and the intelligent readers of these publications are just as much interested in the persual of the advertising pages as of the essays, stories and other features.

The regular classification of the advertisements is a matter which is not always regarded with as much importance as it deserves. Experience has shown that such a classified arrangement of the advertisements is of great advantage to the publisher, to the advertiser, and to the reader. The advertising pages are the main source of profit from any publication, since through them comes the money to pay the dividends. For this reason alone the publisher ought to take the greatest pride in his advertisements, their appearance and their arrangement. They are the hens that lay the golden eggs and should be gently handled. A systematic, well-arranged method observable in the advertising columns of a publication is certainly liable to encourage the advertiser, and a strict classification of all advertisements as far as practicable will prove a great stimulus to new business. If, for example, there were just ten clothiers in one town, of whom nine advertised in a paper, is it not more than probable that in case these nine advertisements were paraded in succession every day before the tenth clothier, he would soon hasten to join the throng? But if the advertisements of these nine had been scattered indiscriminately over the paper, the odd man might never have been induced to advertise. It was only the fact that he found himself left out that prompted him to enter the fold. It is human nature all the world over.

The advertising pages of any publication may be justly compared with a market, or with the business district of a large city. In the market you notice at one end all the butchers, at another all the fishmongers, at another all the green-grocers, fruit dealers, and so on. In the city you notice the dry-goods district, the jewelers' district, the commission man's district, the brokers' district, the woolen manufacturers', etc. Now why should the different advertisements not be arranged in the paper in the same way, when the arrangement in the market and in the city has been a success for years and even centuries? If a man intends to purchase a bill of dry-goods he goes to the dry-goods district, because he knows, that there, by going from one store to the other, he is sure to find what he wants. He asks for prices and compares them. This applies also to advertising. If one wants to buy a

certain article, he is apt to look into the paper for an advertisement of it. If, on turning the pages over, only one advertisement is found representing the goods the reader wants, he will not be satisfied and will look for another paper. The first paper may have had several advertisements of these goods, but scattered and hard to find.

This leads to the conclusion that a business man, having decided to advertise, and having set apart a certain sum for this purpose, should go to that publication which is read by the largest number of people interested in his business, which most probably will be that publication which has the most advertisements and pays the most attention to the manner of setting up and arranging the advertising pages.

The advertising rates in the best publications are very low. Many people, and even some advertisers of experience, will doubt this statement, but that does not detract from its correctness. The trouble is we expect too much from an advertisement. It must not be supposed that a single advertisement, for which perhaps $50 has been paid, is going to fill a store with customers for a year to come, thus bringing a profit on the investment of probably ten hundred per cent. Most people are satisfied, if they make one hundred per cent. on their invested capital, and everybody should commend them for their modesty. Why, then, should a larger profit be expected from an advertisement than from any other investment?

Advertising once commenced, must be kept up, and if conducted with the same thoughtfulness, the same care, and the same business methods exercised in any other enterprise, an advertisement will always prove a profitable investment.

There is one other feature connected with the business of advertising, which, although the writer has so far not made mention of it, is nevertheless of no less importance than the others. This is the manner of composing an advertisement. It is impossible to form any set of standard rules as a guide for the composition of advertisements, except in so far as that they should in all cases be so worded that they will at once attract attention and be read. To be brief, concise, clear, and to the point in writing an advertisement is undoubtedly commendable, and a plain statement is always more liable to carry weight with the reader than a long string of ambiguous phrases, which have no defined meaning when analyzed.

ELECTRICITY

Conducted by Franklin L. Pope.

ACCORDING to the account given by a correspondent, Great Falls, Montana, appears fairly entitled to the distinction of being called the Electric City. At Black Eagle falls, three miles above the town, an immense dam has been thrown across the Missouri, and hydraulic works and power houses erected. Not only are the street-cars propelled and lighted by electricity from the power-houses, but they are heated as well by electric radiators placed in each car. Elevators, printing-presses, cranes, and all kinds of machinery are operated by the ubiquitous force. There are automatic excavators, electric pumps, and electric rock-crushers. A not uncommon sight on the streets is a mortar-mixer attached to an electric wire leading down from a pole. The restaurants cook by electricity, the butcher employs it to chop his sausages and hamburgher, and the grocer to grind his coffee, and so likewise does the tailor to heat his goose. The subtle fluid is a welcome blessing in every home; the housewives run their sewing machines and heat their flatirons by electricity; they bake their cakes in wooden electric cake-ovens that can be set away on a shelf like pasteboard boxes. They have electric boilers and broilers and teakettles. What a singular anomaly when one pauses to think of it: that of broiling steaks and heating flatirons through the instrumentality of a waterfall!

THE most powerful search-light ever constructed was exhibited at the World's Fair by a German manufacturer. The diameter of the reflector is 150 centimeters, and the lamp requires an electric current of 60 volts and 150 amperes. When placed on the roof of the Manufactures building, at a height of 230 feet from the ground, the light was seen as far distant as Milwaukee, Wis.,—a distance of 85 miles. A newspaper could be read by its light at a distance of ten miles. The principal use of these powerful lights is for coast-defense, as by their aid it is possible to detect approaching troops or vessels while at a distance of at least twenty miles.

IN a recent address Sir G. C. Stokes observed that the electro-magnetic waves of the luminiferous ether are strictly of the same nature as those of light, but that an enormous difference exists in respect to the lengths of the respective waves; in the case of light they are about one fifty-thousandth part of an inch, while the electro-magnetic waves which have thus far been investigated vary from a few inches to many yards.

EXPERIMENTS which have been made in France by M. Massin have led to the conclusion that the efficacy of the ordinary form of plate lightning-arresters is dependent upon the distance between the plates, and also upon the degree of polish of the opposing surfaces; that air-gap comb-protectors are less liable than plates to become short-circuited, and that they dissipate quietly a charge which is insufficient to spark across; and that thin paraffine paper is preferable either to guttapercha or mica as a separator for the plates of plate arresters.

IN the central station of the Waukesha Electric Light Co., a 100 horse-power two-cylinder Otto gas-engine has been used for the past year, driving a dynamo supplying 53 arc-lights of 2000 nominal candle-power each, on a circuit nine miles in length. The consumption of gas is said to average 20.6 cubic feet of gas per arc-

light per hour. Of course the direct consumption of the same amount of gas would give nothing like as much light as an arc-lamp. In an experimental test, it is stated that 36 arc- and 300 incandescent-lamps were run on 1400 feet of gas per hour, and in another test 36 arc- and 425 incandescent-lamps were run on 1600 feet of gas per hour. While the gas-engine has been much used in electric work in England, it has apparently received less consideration in the United States than its importance warrants. With gas at a price of $1 per thousand feet, as it is in some American cities, it certainly seems as if gas-engines might be advantageously and profitably employed for driving dynamos, especially in installations of moderate size.

ONE of the most recent novelties in electric lighting is a lamp which has recently been perfected known as the "incandescent arc." It is virtually an arc lamp which burns in an atmosphere of carbon vapor, in a closed chamber. It operates equally well with the direct or the alternating current, and in its practical applications, as well as in its principle, seems adapted to fill an intermediate place between the incandescent and the arc lamp. With a given expenditure of energy, it produces about twice as much light as the large incandescent lamps now in use, the volume and intensity of the illumination being approximately equal to that of an arc lamp enclosed in a ground glass shade. It possesses important advantages over the arc lamp for interior illumination, in that the diffusion of light is much more satisfactory; it is absolutely noiseless, even when run by the alternating current, while a single pair of carbons has been found to burn for more than 100 hours without readjustment or renewal. On the other hand, its superior economy, and the whiter tint of its light, render it better adapted than the incandescent lamp for the illumination of large spaces, such as railway stations, stores, public halls, and the like. Arrangements have been made for manufacturing the new lamp on a large scale.

A SINGULAR scheme of electric lighting is about to be carried out in Antwerp. Water is to be distributed from steam pumping stations, at a pressure of 775 lbs. per square inch, and used to drive dynamos in small district stations by means of turbines. These are to supply the local consumers through a low pressure, two wire circuit system. It is figured out that the cost of coal per 16-candle-power per hour will be only .025 cent. We doubt it.

A DISTINGUISHED French mathematician has proved that with the exception of the so-called unipolar machines, the construction of a continuous current dynamo without a commutator is an impossibility, and that therefore it is useless for any one to waste time, effort and money in trying to invent such a machine. No doubt this is true, but at the same time, one cannot but recall the circumstance that it is only a few years since one of the most distinguished electricians on the other side of the Atlantic published a conclusive mathematical demonstration of the impossibility of subdividing the electric current for incandescent lighting without such a waste of energy as to render the scheme wildly impracticable. We would not disparage the value of mathematics, but it must never be forgotten that, as some one has aptly put it, mathematics is only a mill, and hence the kind of grist you get out depends altogether upon what you put in.

A PROMINENT English engineer contends that experience has shown that silicon-bronze is the best material for electric light and power conductors. The spans may be made 50 per cent. longer than even with iron, while less costly insulators are required. This metal is already largely used abroad for telegraph and telephone lines.

IN a paper read before the International Patent Congress at Chicago, on the Influence of Electrical Inventions, Mr. T. D. Lockwood remarked that from the time of Dr. Gilbert, the court physician of Queen Elizabeth, down to the discovery by Faraday, in 1831, of the correlation between

electricity and magnetism, the record of electrical progress was not one of invention, but of what during that period was infinitely more precious and valuable,—a record of the discovery and application of principles, each successive discovery being the direct consequence of those previously made, and each in turn aiding materially in the evolution of the next. Until these principles had become well understood, it was not possible to make an intelligent application of them. Discoveries are achieved only in the fullness of development; to this the individual is secondary; the discoverer is in a great degree but the mouthpiece of his time. The telegraph has revolutionized the business methods of the commercial world; it has done more to realize that one touch of nature which makes the whole world kin than any other one product of the century of applied electricity. To the telephone, said Mr. Lockwood, we must attribute the renaissance of electrical experimentation which has found fruition in all the victories of the years which have succeeded its introduction. As to its own utility to the world, consider the time saved to each of the 232,000 telephone subscribers of the United States by the 2500 conversations constituting his average portion of the 600,000,000 held over the telephone in a single year; the loss of time in travel saved to the overtasked business man by the long-distance service. In no other country, said Mr. Lockwood, is there a patent system which so carefully fosters invention, and makes easy the path of the inventor, and in no other country is the record of invention in general, and electrical invention in particular, so magnificent as in the United States. It may be that if other countries would try our way, they would find it beneficial. Why not try it?

AT a competitive trial of skill between telegraph-operators, absurdly called a "tournament," which took place last month, one of the most interesting features was a test of the capacity of a receiving instrument technically known as the "audison,"—a small instrument fitted to the head of the operator, giving a sound which, although perfectly distinct to him, is wholly inaudible to any one else. In our opinion it is high time that the use of a receiving instrument of this character became general in the telegraph service. Under the present condition of affairs it is almost literally true, that he who runs may read. Hundreds of telegraphic stations in hotels, railway-depots and other equally public places, are equipped with noisy sounders, enabling every message that goes over the wire, to or from that or any other station, to be read by any person within hearing who is able to do so. There is not the slighest attempt to preserve the secrecy of communication, which ought to be one of the all-important requirements of the service. There are thousands of ex-operators and other persons in the community, who can read these signals as easily as they could read a bulletin-board, and there is obviously nothing whatever to prevent any one of them from obtaining information of other persons' business or personal matters in this way and using it for their own advantage. It is a state of affairs which calls loudly for immediate reform.

THE paper of Professor Thompson on the possibilities of telephoning across the Atlantic, read at the International Electrical Congress at the World's Fair, is exciting considerable interest among electricians. We do not regard it as very probable that this feat will be accomplished in our day, and it is a question whether it would be of much use if it were. A recent critic calls attention to the fact that on account of the difference in time, London and New York have only about three hours of the business day in common, and hence the tariff that would have to be charged would necessarily be prohibitive, inasmuch as the earnings of the three hours would have to pay for fixed charges and working expenses for the whole twenty-four hours. The Paris–London telephone line, on the other hand, seems to have met a long-felt want, and is kept in active service. It is stated that for ten francs 450 words can be transmitted over this line, while only 48 words can be telegraphed for the same price. The cost of

transmitting the same number of words in the United States over a distance equalling that between London and Paris, and indeed, much farther, would be only half as much, or $1, besides which the address and signature would be sent free, instead of being counted and charged for.

IT is very much to be regretted that the exhibitors of electrical apparatus at the World's Columbian Exposition have in so many instances neglected to place some person in charge who is capable of giving an intelligible explanation of the apparatus. Some prominent exhibitors go so far as to prevent, if possible, the visitor from gaining any information of value by his own efforts. This fact has given rise to no small amount of unfavorable criticism and comment among the foreign technical visitors. It would seem as if such a policy must in the end prove a very short-sighted one, and we think it will.

THE total amount of capital which has been invested in central-station plants in Great Britain is estimated at no less than £4,500,000. At the present time, however, there is in that country a decided tendency manifest to place all central-station supply systems in the hands of the municipal governments.

THE Boston public library now contains a remarkably large list of works on electricity, and especially relating to the telegraph and telephone. A catalogue of these last was published in the April bulletin of the library.

THREE years ago the bright little son of a Maine clergyman, not more than a dozen years of age, while on a visit to Boston with his father, became deeply interested in the operation of the trolley cars, and suggested to the writer of these notes that he thought it would be a good idea to build an electric fire-engine that could propel itself on the street-car tracks, and be run off on the pavement and set to work wherever electric power could be derived from a trolley wire, or by a special electric connection located in the vicinity of each hydrant. It is now stated that such an electric fire-engine has been built by an engineer of St. Paul, Minn., and exhibited to the fire commissioners of that city. It is said to weigh less than half as much as a steam fire-engine of the ordinary capacity, while its power may be readily increased to almost any extent. With an electric supply available at almost every street corner, as is now the case in most large cities, it would seem as if the steam fire-engine must of necessity soon be superseded by its electric rival.

IT IS announced that the Milford and Hopedale electric railway, which has been operated for a long time by the storage-battery system, with results which have been claimed to be highly satisfactory, has been compelled to suspend operations, in consequence of an injunction obtained by the owners of the controlling patents on storage-batteries, which the courts have decided to have been infringed by the apparatus in use on that road.

EXPERIMENTS have recently been made with a view of determining whether the quantity of heat developed in the rheostat —which is one of the necessary evils in the operation of electric railway motors— is sufficient to be of any practical assistance in warming the atmosphere of the car. The conclusion arrived at was that the amount of heat which could be thus realized is not sufficient to warrant the expense of providing special rheostats. Incidentally, however, these results go to show that the actual loss of power due to rheostatic regulation, as compared with commuted field-windings, is much smaller than has usually been assumed.

ONE of the longest electric railways in the country is that from Oakland to Hayward's, California, a distance of fifteen miles. The cars on this road make a speed of 35 miles per hour, and the distance between the termini has been run in 35 minutes. Some of the cars run an average of over 200 miles per day. Great care is taken in respect to the inspection and repair of the motors.

IT is said that the largest dynamo-electric machine in the world is that which furnishes power for the intramural electric railway at the World's Fair, its capacity being 1500 kilowatts, equivalent to 2500 horse-power. The capacity of the railway for heavy work bids fair to be pretty thoroughly demonstrated before the close of the Fair.

OUT of a total of some 300 miles of electric street-railways now in operation in the various countries of Europe, more than one-half is equipped with machinery of American manufacture. The over-head trolley system is used on about two-thirds of the total mileage.

A TWIN conductor cable for high speed working on submarine lines has been invented by the electrician of the Post Office Telegraphs of Great Britain, which is expected to eliminate much of the difficulty hitherto experienced from inductive interferences, and to greatly extend the distance through which it is possible to speak by means of the telephone. The principle of the invention is understood to reside in the particular geometrical form and relation of the two conductors with reference to each other and to the insulating medium in which they are inclosed.

THE Postal Telegraph Department of Great Britain had a very interesting and instructive exhibit at the World's Columbian Exposition. Among other articles worthy of note may be mentioned some of Cook and Wheatstone's early apparatus of 1840; a section of the first five-wire telegraph, laid in a wooden trough between Euston and Camden in 1837; sections of the first submarine cables laid between England and France in 1850; and a large number of specimens of historical and obsolete apparatus illustrating the evolution of the art of telegraphy during the past fifty years.

IT is but a few years since all the finer and more accurate instruments for electrical measurements were imported. To-day, it is admitted that the best ammeters, volt-meters and watt-meters in the world are of American manufacture, and a large export trade in these articles has sprung up. The methods so successfully applied in the manufacture of American machine-made watches have been adopted in the class of work referred to, with the most successful results.

ONE of the arc-light dynamos exhibited at the World's Fair is capable of supplying 125 2000-candle-power lights, giving a potential of 6250 volts at 525 revolutions per minute. The current is about 9.4 amperes.

IT has been found by experience that the return circuits of electric-railway systems are best made of iron when buried in soils containing clay and quicksand, while in dry gravelly and sandy soils, copper is preferable.

THE plan of using large multipolar dynamos directly connected with the driving engine, which appears to have originated with the Swiss engineers, is gradually gaining in favor in all countries. One of its most important advantages is due to the saving of floor space,—no small consideration when a plant occupies costly real-estate in the heart of a large city. One plant now in actual operation consists of four 75 horse-power engines, the same number of 50-kilowatt dynamos, and a switchboard, these being all contained in a room 20 feet by 18 and 8 feet high, with plenty of space for the attendants to get at any part of the machinery for repairs or renewals.

ONE of the principal journals devoted to electro-technical matters now announces that its columns are printed from type set up by type-setting machines driven by electric motors. A critical examination of the work shows that it is very well done, the uniformity of the spacing and the clearness of the type, which is new every issue, giving the page a very attractive appearance.

ARCHITECTURE

Conducted by Barr Ferree.

IT'S over at last; the World's Columbian Exposition has gone into the past. This gigantic enterprise that cost a fabulous sum of money, that consumed the energies of an army of men, that occupied the thoughts of the thinking world for months, even for years, and, last, but not least, has elevated the city of Chicago to the utmost pinnacle of fame, has made her name a household term the world around, and has poured uncounted wealth into her coffers, albeit the work of the receiver and the sheriff has not been idle in her midst during the past half year,—this gigantic enterprise, after a brief but brilliant existence of six months has come to an end amid universal rejoicings. Ends do not usually create feelings of this nature, but the Columbian Exposition had lived its life, accomplished its duty, made some rich, others poor, and it was time that it should go and leave less conspicuous influences to determine the coördination of affairs in this country and the rest of the world. While the Exposition failed, in many minor particulars, and some major ones,—to wit, architecture,—as an illustration of what the American mind has accomplished, while our contact with foreign nations through it has not been as close and as varied as it might have been,—surely the Midway Plaisance and its mess of messes is not to offset this,—it was undoubtedly a very striking display of our national resources and our national growth and character. More than anything else it was an American exhibition; through it we have learned to know ourselves as we perhaps did not know before. If it was lacking in any one feature, it was in that it did not bring out our weaknesses in contrast with our points of strength. It was not a complete picture. It showed only our glories, pointed out our greatness, and left us with a false notion of our importance. Perhaps this could not be helped; perhaps it did no harm, but at all events it was an omission. And yet it was a misfortune that, while the exhibition so well illustrated American resources, it did not do so more completely. The exhibits should have been more systematic; they should have been better arranged and, above all, there should have been an abundance of brief, popular handbooks that would have made the resources of the exhibition of value to every one. It may have been too much to ask for these for a collection brought together for so short a time, but if a thing is worth doing at all, it is worth doing well. However, all this belongs to the past and cannot be helped now. As it was, the exhibition contained more than any one man could master in twice the time. This was another source of weakness, for one is continually running against people who saw everything in three days. We verily believe that one could see more at the Columbian Exposition in three days than at any other place on earth, but that would not be seeing the Exposition. The Fair has been an enormous success and every one concerned in its making can take his full share of the credit. Even the New York *Sun*, in the last month of the Fair, patted Chicago on her back and remarked that she had done well. If higher praise than this can be found on this planet we should be glad to know what it is and where it can be had. With this Chicago may well feel satisfied.

A SECOND visit to the Fair confirmed our earlier impression, that while it has a wonderful power and dignity, considered as a whole, the buildings individually, speaking generally, are wanting in detail and abound in faults of design. We have

previously had occasion in these pages to refer to this and more need not be said. The Court of Honor is unquestionably a superb piece of architecture, the view towards the peristyle being especially dignified, with the stately statue of "The Republic" immediately in front. The reversed view is not so good, though that towards the Colonnade, between the Palace of Mechanic Arts and Agricultural Hall, is almost as pleasing. The reverse of this view, however, is something to be ignored, since the vista is closed by that miracle of astounding architecture, the Illinois State building. A continued acquaintance with the Fair-grounds likewise confirmed our earlier impression that, while the landscape gardening, of which so much has been said, is unquestionably very fine to look at, and adds immensely to the appearance of the buildings, it is totally unsuited for practical purposes. One got wearied before one got anywhere. The distance to a good restaurant, or what passed as such, from almost any portion of the grounds, was appalling. The intramural railway landed you scarcely anywhere that was convenient. Everywhere there was walking, walking, walking. Short cuts were impossible, because you were invariably shut off by a lagoon or a lake. Transportation by water was costly and not always convenient. There was, in fact, no end of the trouble put upon the visitor by this much bepraised and belauded landscape gardening. The highest test of any architectural work is its utility. The usefulness of the grounds should have been the first thought of the designers. Every effort should have been made to save steps, or, if an elaborate arrangement was desired, some cheap, rapid, and desirable surface carriage should have been provided. People who do not know what landscape gardening is must, after the Fair, think it something very dreadful, based on the idea, if possible, of making people go twice the distance to reach a certain point when they might only go half by going another way. It is very beautiful, we admit, but very horrible to the sightseer. And these were the people to be consulted. An architect does not make a design irrespective of the uses to which his building is to be put; that must determine its ultimate form. By neglecting this elementary idea in the laying out of the Columbian Exposition the art of landscape gardening has been degraded in the public estimation, and from a noble art for a noble purpose has shown itself incapable of realizing the fundamental elements of all work of practical utility.

THE enclosures surrounding the national exhibits in the Manufactures building at Chicago were not altogether successful. This was a matter, we believe, that was left to each nation to settle for itself, but however it was done, the work did not, as a whole, reflect any particular credit upon those concerned in it. The enclosures built by several of the smaller nations were, artistically, little better than fences. Russia had a somewhat imposing pavilion in its national style of architecture, ugly enough in itself, but interesting for its novelty and because it was a well-meant effort to produce something. Spain did as well as could be done with an application of Moorish arches from the mosque of Cordova, which were cleverly enough placed under the gallery that covered most of the Spanish exhibits. The galleries of the Manufactures building were one of the great failures of the Fair; no one would go up to them, and they thoroughly ruined anything placed under them owing to the utter disregard of lighting by the architect. Spain was especially unfortunate in this respect, and it was the more remarkable since the Exposition itself was in honor of Spanish energy put forth four hundred years ago. Italy and Belgium had interesting Renaissance pavilions, which, while not being pretentious at all, fulfilled their purpose thoroughly well. In some respects the French pavilion was the most noticeable of the series, as it certainly was the most pretentious. It was the only one that gave any indication of resting upon an intelligible idea, which was to form a series of frames or enclosures to particular exhibits. But, while the idea was good, the execution of it was not, for the figures that supported the cornice

were much too large for the work they had to do, and the whole effect was much too heavy. The entrance was well managed, notwithstanding some very bad wall paintings, but the effect of the half-dome was totally ruined by being made of canvas, a circumstance quite obvious to the eye. An architectural construction that waves to and fro with every breath of air is not one that commends itself to thinking people. But, however one may be disposed to criticise the architecture of this enclosure, it is impossible to do anything but give the highest praise for the admirable and artistic manner in which the exhibits were arranged. Of all the sections in the Exposition, the French department of this building alone was arranged as a whole. The best possible use was made of every exhibit, and while many of these were crowded, the general effect was very fine. This section pointed a lesson which other departments might well have taken advantage of. The German pavilion was conspicuous for its great Armbruster gates, huge pieces of wrought-iron that were extremely impressive. The pavilion itself was constructed in a receding fashion, going backward and upward in a manner that was sometimes a little confusing. Its architecture, on the whole, was uninteresting, as was also that of the adjoining Austrian pavilion. Least satisfactory of all,—an abomination of abominations,—was the clock tower placed in the center of the building. Its position was exasperating, since it was deliberately placed in the middle of the most crowded part of the building. And its architecture? Bad, bad, bad.

THE displays of household art at the Columbian Exposition were somewhat confusing. One had scarcely got into the Manufactures building before he found himself in the midst of the Italian furniture. This was packed into twice the area it should properly have occupied. It was very much carved, with a superficial richness of effect the Italians seem to be thorough masters of. Anything worse than this stuff it would have been hard to find. The carving which covered almost every inch of surface was very bad indeed; the inlaid furniture was, if possible, worse, and the whole display was as uninteresting and depressing as could be imagined. It is not at all indicative of the distribution of correct taste throughout this country that the sales in this department seemed to be very large. The low prices of some rather pretentious-looking articles of furniture doubtless accounted for a good deal of this. France, Germany, and England were well represented in furniture, France leading in point of quantity and variety of exhibits, but with Germany a good second. England, though represented by only a few firms, made an excellent display. The furniture was good, the carving well suited to the pieces to which it was applied, the designs well chosen and graceful, the inlaying, of which there was quite a display, rich and appropriate, and the whole effect very good. The exhibit of Messrs Hampton & Sons, who sent a reproduction in carved oak and modeled plaster of the banqueting-hall in Hatfield House, was especially noticeable. This very costly display reflected infinite credit upon its makers, who deserve the greatest credit for their enterprise. In Germany the most conspicuous exhibit was a suite of three rooms in the German Renaissance of the sixteenth century. These were decorated and furnished with an astonishing amount of richness, and a throne-room at one end, containing furniture loaned by the crown of Bavaria, was unsurpassed in gilding and the splendor such ornament suggests. The German display also included sundry small rooms, several of which were furnished in excellent taste. The French exhibit was more extensive than either of these, but it was by no means as successful or as pleasing as the English. Most of the furniture shown was covered with tapestry or brocade. There was relatively little carved work; some charmingly painted pieces were shown. All these foreign displays included many huge articles of furniture quite unsuited to the average American house, and also, we should think, to the more pretentious American dwelling. The displays of American furniture, on the con-

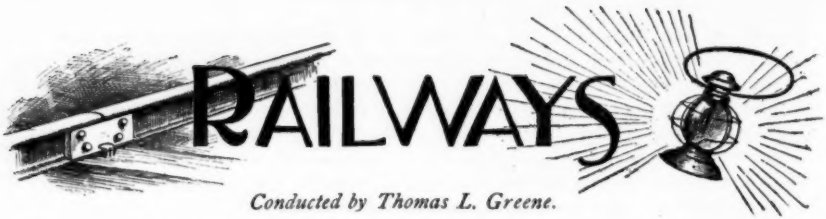
trary, were eminently useful and "home-like." It was furniture made to be used, and sold at, apparently, not too high prices. Most of it was in hard wood, of very excellent design, and very pleasing finish. Though it could not compare, in richness of effect, with the more elaborate displays of foreign countries, it was very creditable and very satisfactory.

THOUGH the display of architectural appliances at the Fair was not large, it happened that the collection of elevators was varied and extensive. This followed, naturally, from the size of the buildings and the utilization of their roofs as promenades and for restaurants, and similar purposes, all of which necessitated the use of elevators. Most of these were treated as exhibits or parts of exhibits by the manufacturers, and very good exhibits they were. This, of course, helped to distribute the displays throughout the grounds, but, after all, most of them were limited to three places, to the Transportation building, the Electricity building and the Palace of Mechanic Arts. The variety of elevators was so large that it seemed to us we might well improve a portion of our time at the Fair by studying them. At least here was one subject one could learn something about, for the material was ample and the opportunity for study apparently sufficient. Alas and alack for our good intentions! Sundry bold bad men, belonging to various elevator-makers, had disguised themselves as would-be purchasers, or country cousins or similar innocent folk, and had sought to find out from the representatives of other elevators full particulars concerning the idiosyncrasies of their machines. It seems almost incredible that such wicked folk should exist, but we were assured that they do and did. The immediate result of this was a demand, from the elevator-man, for your biography and your standing in the community. They did not inquire as to your commercial rating, nor did they ask after the condition of your bank-account; they professed simply to wish to know whether you were a proper person to talk with about their machine. As we happened to be "doing" the elevators *incognito*, this circumstance somewhat baffled our studious inclinations, as we quite failed to see how any man could invent a machine, patent it, and then keep the construction wholly to himself. The net results of our labors were, therefore, much more limited than we had hoped. Briefly stated, we think the result of our researches may be stated thus: Firstly; there are four sorts of elevators: those worked by steam, by electricity, by hydraulic power, and on the pneumatic system. Secondly, the last elevator you see is the best, is provided with more and better safety apparatus than any other, is the most economical, the swiftest, the best built,—in short, the one to buy. We do not know if these propositions are especially valuable or not, but that is the net result of "doing" the Fair *incog.*

A STRANGE medley of architectural models one might have collected at the Columbian Exposition if one had had the time and if the objects were themselves collectable. We have frequently taken occasion to deplore the lack of systematic architectural displays at the Exposition, but taken first and last, a goodly number of architectural illustrations were contained in it. In the Anthropology building, which housed a most interesting collection of curiosities, were a number of models of the dwellings of primitive peoples. Some of these were made by the Department of Ethnology, which started out with brilliant plans and failed to put them into execution. But disjointed as its work was, it accomplished a good deal and secured a number of beautiful models. The actual houses of the American Indians which were placed outside this building were not so successful as they might have been though they were genuine buildings. The casts of prehistoric structures from Yucatan, while very interesting in themselves, quite lost scale by being placed in the open air and thus in direct contrast with such enormous structures as the Agricultural Hall. Various other models and reproductions were scattered throughout the exhibitions. There were models of fish-

houses and fisheries in the Fisheries building. There were schools and schoolhouses in the educational displays. There were charitable institutions and prisons and hospitals in the Anthropology building. There were flour-mills and breweries, the last large and beautiful models of the greatest interest, in the Agricultural building. There were models of railroad-stations and train-sheds in the Transportation building. There were models of Japanese palaces and temples, veritable works of art in wood and metal and executed with the utmost nicety and skill, in the Palace of the Fine Arts. There were models of farms and of stables and of cow-sheds in Agricultural Hall and in several of the State buildings. Wherever one might go, one came across an architectural exhibit of some sort, and if they had all been brought together in one place, they would have made a most interesting show. But this was not to be, and we have no doubt that, closely as we searched for them, many interesting pieces of work escaped us. What will become of these things now that the Exposition has closed, we do not know. Many of them will doubtless be thrown away; others will return to their makers to slowly find their way to the attic and junk shop; others, again, will be housed in the Columbian Museum that Chicago has founded to take care of anything anybody will give to it. The architectural value of a good many of these things is not very high, but they all indicate some architectural idea, and, if brought together, would form a really valuable collection.

In dismissing the Columbian Exposition from these pages for the present, a word or two may be devoted to the critics who have been having so much to say during the past few months. The quantity of slush that has passed for criticism of the Fair which has been printed in the daily, weekly, and monthly press of this country is prodigious. Editors, apparently, have accepted almost everything, and ability to compose art criticisms does not, if one may judge by the work given the public, rest on a discerning mind or a clear understanding. Had 90 per cent. of this stuff been left unwritten and unprinted, the world of art would be better off to-day. From this unsavory mess it is only possible to take one or two illustrations, but they shall be typical ones. A good deal has been said by unthinking people about the Transportation building and its decoration,—a not unnatural circumstance, since it is clearly the most novel and interesting of all the Fair buildings. Yet very few of the people who have undertaken to instruct less wise persons about it have tried honestly to understand it, while an even smaller number appear to have kept in mind the fact that the building was built to be decorated in the fashion it is, and that unless criticised from this standpoint it cannot be criticised at all. Yet a writer in *The Nation* finds it "an entertaining salad of styles" and his only positive expression of opinion is a quotation from the London *Times* to the effect that it is "shabby." Into the mental operations of a person who writes in this style it is impossible to enter, but it is to be regretted that *The Nation*, which counts a number of perfectly competent critics of painting and architecture among its contributors, should not have delegated the task of describing the buildings to one of these, instead of accepting the utterances of a man who has no opinion of his own but must reproduce the remarks of an unknown Englishman. Quite in the same line is *The Art Amateur*, a paper which prides itself, we believe, on its artistic excellence and appreciation. It is covered with regret in admitting that the Transportation building "is a complete failure," though "architecturally the building is far from bad." It is not to be wondered at that after this it can find little that is good in the color decoration that is the *raison d'être* of the building. It is quite true that the architecture of the building is "far from bad," but it is also true that the person who wrote these words did not try to look at the building as its author intended it should be looked at, and that he was so wedded to preconceived ideas and precedents that a noble, fresh, original work like the Transportation building could make no impression on his mind.



Conducted by Thomas L. Greene.

THE annual reports of railways now being published for the fiscal year ending June 30 prompt the remark that there is a gradual improvement shown from year to year in the make-up of these exhibits. More information is now given to the public and the statistics are arranged so as to be better understood. The old feeling that the income and financial *status* of a company was "nobody's business" is giving way to the belief that an honest statement is one of the best defenses against Wall-street or legislative attacks. The work of the statistician of the Interstate Commerce Commission, though in some important respects subject to criticism, has had its effect nevertheless upon railway opinion regarding reports and also upon more correct methods of accounting. Two roads—the New York Central and the Denver and Rio Grande—have introduced a new table. It might be called a treasurer's statement, as it is intended to show in brief the sources of the moneys received during the year and their disposition. This, it will be noticed, is more than an income account, since it embraces the cash received from bonds or from borrowings, as well as the surplus earnings from operation. But where reports do not give such a table the interested bondholder or stockholder or railway-man can make up one for himself by comparing the corresponding items of the general balance-sheets for two years. Thus increase in assets would consist of increases in cost of road and other like items, together with decreases in liabilities. On the other side should be put increases in liabilities such as in bonds or accounts or bills payable, and also decreases in assets, which latter item, for bookkeeping purposes, is equivalent to an increase in liabilities. The test of the accuracy of such a table is in having the charges on both sides foot up the same. The use of such a table is in revealing things which the ordinary statistics do not touch. For example, the Chicago, Milwaukee and St. Paul report states the charges to capital for equipment and improvements for the year at $2,877,817, while a comparison of balance-sheets shows the increase in the item cost of road to have been $3,678,381. This leaves an expenditure of about $800,000 unaccounted for, and though doubtless this represents merely some shifting of other items, it is better to have all such discrepancies set out fully in public reports.

THE Wabash also furnished a good and clear report. This company occupies a peculiar position in that it has no construction account, for the reason that it is mortgaged to its full value or even more and cannot issue new bonds. Hence improvements—and every road must improve its property in some way—are paid for from earnings, while the distinction between betterments and operating expenses is not drawn as closely as with other railways. The Wabash by this method is steadily though slowly bringing its roadbed and equipments up to the best standard in its section. Payments on its debenture B bonds would be a fatal mistake, for that would deprive the company of the money absolutely needed to spend upon the road in order to compete cheaply and safely with its rivals. It may also be mentioned that the statistics in the Chicago and Northwestern report are very full and put the investigator in possession of all the facts needed to form an intelligent opinion. It is only those roads which have something to conceal that are willing to put blind or misleading figures in their annual reports.

THE business depression and loss of gross earnings brings up prominently the question of wages. Many leading roads have cut down pay-rolls and discharged men in the shops. The proposed reduction in the wages of train- and engine-men has been openly resisted or grudgingly yielded to for the moment. In a few cases this reduction has taken the form of a loan to the road by the employés of 10 per cent. of their wages. Since all companies and firms are suffering from the financial and business situation, it is right that railway employés should accept losses with their employers. Sometimes, however, there is coupled with this reduction the further theory that employés should receive less wages generally and permanently. Advocates for lower wages point to the fact that the ratio of operating expenses has steadily grown larger; this is owing in part to higher wages, but in greater part to a general fall in rates. If rates were but fair and well maintained, the recent increases in wages would not be such a burden. The employés, on the other hand, argue that if wages were permanently reduced and the same "cut-throat" competition allowed to continue, it would not be long before the lower level of expenses would be reached by the declining revenue through a further reduction in rates, when the same question would again come up. If it is a question of wages and rates—it is said—it might as well be fought out on the present level of payments as on a scale of wages 10 per cent. lower. From this point of view the problem of reasonable and fair tariffs for the passenger and freight traffics, if we could solve it, would at the same time help greatly to solve the present labor problem also. It ought to be and doubtless is the wish of every railway manager to pay good wages. Railroading is a hard and dangerous trade, and those who follow it ought to receive corresponding remuneration. Moreover good wages are necessary for the maintenance of that discipline which is essential to the safety of goods and passengers. While, therefore, railway managers are compelled by the force of present circumstances to consider reductions in wages, they should and usually do recognize the claims of their men. They should also consider the other side of the problem—the question of increasing the earnings. Our companies are too often assailed by legislatures and find their revenues reduced thereby, while a national law at the same time takes away their only legitimate defense—combination. Every legitimate means should be employed to educate public opinion in this direction, not only as a matter of justice to carriers, but also because the matter involves the question of safety and the best service to the community.

IT is a little surprising that no American road has adopted the English system of insurance for employés. The Pennsylvania and the Baltimore and Ohio have excellent relief departments under which the funds of the men are administered by the companies, free of charge. A number of roads have built hospitals and employed surgeons for the care of those injured; while all companies spend money for the relief of disabled employés in various ways. Yet it is all indefinite and somewhat of the nature of charity: it forms no part of the implied contract of employment. When the employers' liability act was passed in England, the British railways took alarm—needlessly, as it has turned out. They instituted departments for insurance against accidents, death, and old age. Membership was made compulsory and servants had to waive their rights under the act. In return the companies agreed to contribute to each fund an amount each year equal to the total contribution of the employés. These funds are managed by committees formed from railway officers and servants, and the scale of payments is figured out by actuaries according to the statistics of accidents in past years. These funds have now accumulated balances amounting to several millions of pounds sterling. In the accident department, for example, each trainman pays 6 cents per week. He is entitled to $500 in case of death by accident or permanent disability; or weekly allowance of $5 when temporarily disabled. The officers and clerks receiving regular salaries contribute 2½ per cent.

of their stipends to a superannuation fund. Upon retirement each receives as a pension a percentage of his salary, that percentage varying with length of service; after thirty years' service it amounts to half his salary. There is also provision for death. Another fund provides pensions for the wage-earners. When it is remembered that railway servants of all classes in England receive much less pay than our own men, these sums are very liberal and are to be measured by the small payments required. If a man leaves the company's service in good faith he receives back his own contributions only. If he is discharged for fraud or dishonesty he forfeits the whole, at the option of the company. In this simple plan of insurance may be found one of the reasons for the excellent discipline on the English railways. The company testifies to its interest in its employés by contributing to their insurance from its own earnings. In the United States, unfortunately, there has grown up a feeling of antagonism between the corporation and the employé. What can be done to bring these two great forces into better sympathy with each other? The plan of insurance against death, disability, and old age, through the help of the company, would do much to bring about a reconciliation, to say nothing of the relief to the injured from the point of view of humanity. Why does not some American company try this plan?

Of the large commercial and financial questions awaiting solution in the United States none is more complicated than the anthracite problem. Practically all the hard coal in the United States is embraced in about 480 square miles of the State of Pennsylvania. This territory divides itself into three regions, the Wyoming, the Lehigh, and the Schuylkill. From the first region the coal is carried principally by the Delaware, Lackawanna and Western, the Delaware and Hudson, New Jersey Central, and the Erie roads. The Lehigh Valley is the main coal-carrier from the region of the same name, while the Philadelphia and Reading's holdings in the Schuylkill region comprise nearly half of the entire coal area. As the carriage of this hard coal has from the first been the main business of these carriers, it was early seen that the ownership of the lands would secure continued tonnage. So auxiliary companies were in most cases formed to hold these lands whose stocks were held by the railways. The present constitution of Pennsylvania forbids this, but the railway charters antedate the constitution.

These several railway companies found themselves rivals in supplying the anthracite trade, and as the capacity of the collieries opened was greater than the demand, more coal was thrown upon the market than could be consumed, with a consequent fall in the price. Agreements with each other to restrict production would avail for a time, but when one company got ahead of its agreed proportion, some other would cut prices to keep up its percentage. This in brief has been the history of the anthracite wars. Gradually the price of anthracite declined until it was just high enough to pay a return on the lightly capitalized companies, including the money invested in the mining subsidiary companies. As the price of coal sought this level under overproduction and the working of well known economic laws, the rate of freight did not change correspondingly; so it came to pass that the profit to the carrier from transportation was enough for the purpose even after deducting the deficits of the mining companies which were run at a loss. But while the great companies held the majority of the coal-lands, a part was still in the hands of private owners—individual operators, who after paying the public rate of freight had not enough left from the selling price to meet expenses. Hence one large firm sued the Lehigh Valley before the Interstate Commerce Commission for a reduction of tolls, forming a most complicated case which the Commission decided against the railway. The decision however has never been enforced.

Meanwhile the Reading company was in a peculiar position. Under the leadership of the brilliant McGowen it had acquired the large coal area mentioned, yet at the same time the rival carriers, though own-

ing less coal land, had expended their capital in building railway lines and in other ways to reach more extended markets. The Reading, with an ownership of over 40 per cent. of the whole territory, found that it could carry and sell less than a quarter of the anthracite output. Moreover the cost of mining is slightly greater in the Schuylkill than in the other regions. The reorganization of the Philadelphia and Reading Company followed in 1886 through the issue of "preference" bonds, whose interest was payable only if earned. In 1892 control of the Reading passed to Mr. McLeod and his friends, who succeeded in combining the Reading, Lehigh Valley, and New Jersey Central. With the acquiescence of the uncontrolled companies the price of coal was advanced a year ago about $1 per ton, at wholesale. Mr. McLeod's ambitions led him to seek further markets for Reading by planning to control several important roads in New England, as well as by a purchase of all the output of the individual operators whose "free" coal had always been a menace to prices under the high toll system. Under various ambitious schemes Mr. McLeod was led to borrow largely, while attempting to secure the favor of the preference bondholders and to keep up the price of such collateral as he had hypothecated by declaring the interest on these income bonds earned. Not being able to borrow longer, the crash came and Reading was again put into the hands of receivers, where it still remains.

The future of Reading depends largely upon the future of the anthracite trade. High prices imply restriction, while no company is willing to give up any of its earned trade to favor Reading. A comprehensive plan for distributing the coal tonnage requires a combination of all interests which has never yet been attained. Meanwhile many expensive collieries are run at a loss merely to supply coal tonnage to the owning railway. In fact the high freight tolls on anthracite invite new competition and were a principal factor in bringing about the present complications, yet they are hardly likely now to be materially changed without a severe struggle. The cost of mining is on the average about $2 per ton on the cars, including all charges, interest on plant and royalties, the freight toll to tide water being $1.75 per ton for a haul from 100 to 150 miles. What the situation will bring forth no one can say; perhaps a better agreement, either by a unification of interests or possibly through another coal war.

THE shocking railway accidents of the last two months, resulting in loss of life and property, point out a defect in our system. These accidents were due to various surface causes: in one case the block-signal operator let in the following train before the preceding one had left the block, precipitating a bad collision; another collision was caused by an employé substituting one meeting place for another in the train order on a single-track road; on another road a bridge undergoing repairs was not protected by cautionary signals to trains to slow up and was left in a weak condition while the gang went to dinner; and so the list grows. It is not possible in a limited space to discuss each accident in detail, but one thing is of overshadowing importance—discipline. Were these employés competent? Were they selected for their responsible positions with care? Were they watched? Were their infractions of the rules punished? In short was discipline fully maintained? In most cases of accidents lack of discipline and an inferior class of men, are the underlying trouble. We have in the United States no such well-trained and well-disciplined force of employés as serve to keep the English railways comparatively free from accidents. For this state of things the railways themselves are partly responsible. They hire mere boys for telegraphers who have the handling of train orders in which a mistake may mean death. They allow a signal-man to fool with his semaphore without punishment. They are not thorough with their men. The railway excuse is, however, often good. To keep good and well-trained men costs a great deal of money, directly and indirectly. The average superintendent is judged by his economy, false though

that standard really is. Bond interest and dividends might disappear if expenses were not kept down. Yet safety costs money. Passenger fares in the United States are on the average high enough, but freights are often too low, especially when rates are "cut." One part of the responsibility for a lack of safety must therefore be put upon the public, which wishes its transportation at such low prices as not to admit of paying comparatively high wages to the best men. Each road, however, must be judged separately in the matter.

EVERY new thing has its dangers, and the new theory about railway receiverships discussed last month is no exception. If receivers for a corporation may be appointed at any time, at any hour, without notice, on application of men who happen to be creditors to a small amount (and every company owes money) and on consent of the president or other officer of the company, then it is evident that a few unscrupulous men, by taking advantage of their position, may put any corporation in great peril and cause widespread loss. It is equally true that we have very little of such a procedure to record. Great reliance is properly put upon the honesty of our higher judges, before whom such applications come. Those judges are men of character as well as learning, and may be relied upon to reject dishonest attempts to wreck corporations. Officers of our large companies as a rule are also trustworthy men; though the possibility spoken of adds one more to the many reasons why stockholders should choose their officers with the utmost care. Business must be carried on by men, and the managers of large interests must be given discretionary power. So far the practical effect of the new theory of railway receiverships has been undoubtedly for good.

THE several collisions which have occurred on roads equipped with block signals and on those without that device, have again raised the question of the utility of that system of signaling. As to the more simple form of blocking, wherein a semaphore signal is moved from "safety" to "danger" by the hand of the operator on the report that the block is clear, certain railway men are not yet convinced that we have gained much over the plan of depending upon the rear brakeman. Will not the signal-man in the tower blunder as easily as the brakeman? Do we not know by experience that merely substituting one man for another does not solve the problem of safety? These questions, however plausible on their face, do not go quite to the bottom of the question. In adopting simple blocking a road does indeed substitute one man for another, but the important point is that we substitute also a rigid set of rules which can be lived up to for a system which in the nature of the case must be more or less elastic. An engine-man is not looking for a rear brakeman, but he is on the lookout for a fixed signal at a stationary tower. The tower-keeper should be governed by instructions which he need never have any excuse to violate, and whose violations, if made, can be known and punished. In short, semaphore signaling reduces collision signals to a system.

ON the other hand, the rear brakeman is often asked to go back under circumstances of hardship. Or, perhaps a dangerous and slippery trestle is in front of him, where safety is in question. We ought not to put too much stress upon poor human nature at $600 or $800 a year. Then, although the standard rules say just what he shall do under ordinary circumstances, they do not say what should be done when anything unusual occurs. The rules do not cover the point. When we rely upon the judgment of an employé in cases of sudden danger demanding knowledge of trains, keenness of mental sight, and coolness, we must expect that these qualities will fail the average trainman in a given proportion of cases. But by substituting a space interval for a time difference between following trains, we in fact introduce a possibly perfect system where before there might be doubt of safety even under the most favorable conditions.

MINING & METALLURGY

Conducted by Albert Williams, Jr.

EXTREMES of economy in the cost of any operation or manufacture are apt to be misleading and often tend to miscalculations on the part of too-sanguine projectors of similar undertakings—or rather undertakings of a similar general character but in which all the conditions are not precisely duplicated. Still, it is always interesting to note these extreme cases; for, while they fail to establish standards for work under average or less favorable circumstances, they at least serve to show what may be done under the best conditions. Further, it should not be forgotten that in no one works where a number of considerations must be taken into account—and this applies with especial force to the mining and reduction works, where the conditions are very complex and variable—is it likely that *all* of these conditions will be of the best. In some one or another detail there will be always an advantage somewhere else. So those mines and works which give the most economical results are the ones which have the best total average of favoring conditions, which, though indefinitely numerous in minor details, are, in the case of mines, grouped under these main heads: size, character, and richness of deposit; scale of operations; ease of working, with reference to hardness or toughness of rock, amount of timbering needed, explosives, tools, or power-drills, etc.; nature of openings, whether open cuts, shafts, inclines, or adits; altitude and general surrounding topography; climate; presence of water; temperature at great depths; facilities for using water and electric power; available local supplies of timber, fuel, etc.; communications with points of supply and distribution, as to means, time and freight rates; character of labor; wages and cost of living; ruling market prices for all items of supplies and products; and, of course, skill in technical management and in business administration. It will be easily seen that under each of these and other principal heads a long list of minor details could be enumerated, all of which have more or less weight in the final result. At a large metallurgical establishment the complexity of influencing conditions are even greater, for while some of the mining conditions are dropped, a greater number of new ones are introduced. Then, again, taking a broader view, not only do the conditions at the mines and metallurgical plants mutually affect each other, but they are also themselves affected by a series of apparently outside influences, such as legislation, competition, state of the money market, progress in the manufacture of machinery, and so on indefinitely. The point of all this is that when one comes to figuring probable costs and results in any mining or metallurgical enterprise, the task is not as simple as might appear. The estimate never includes more than a part of all the factors; but whether the estimator is conscious or unconscious of their existence, they are all the same in the actual result.

TO RETURN to the matter of low costs: Taking the concrete example of the production of gold by the two simplest methods, hydraulic placer mining and the working of free-milling ores, some surprisingly low figures are arrived at. In the famous case of the North Bloomfield hydraulic mine, of Nevada county, California, where an immense mass of low-grade top gravel was piped off in a long run, it was found that a yield of two cents per cubic yard covered all expenses. If gravel were rated by weight instead of by measurement, this would mean that it was handled at a little

over a cent a ton. Such a statement may seem incredible to those not familiar with the possibilities of hydraulic mining on the largest scale, under the greatest advantages and with the best skill; but it is a matter of record. Now to estimate on this basis for an ordinary placer mine would be absurd. There are not so very many records of success where the gravel ran lower than ten cents a yard. Some mines of large deposits, with a plentiful and cheap water supply, ample dump room, and a fairly long working season, have paid well on lower than ten-cent gravel; still, in projecting new hydraulic mining enterprises, it is always well to allow a wide margin above expectations founded on the historic records.

THERE are many other kinds of placer mining besides the hydraulic method, such as river mining, shovel-sluicing, "booming," etc., most of which are as obsolete as the old pan and rocker, and which, being on a small scale individually, are much more expensive than hydraulic mining. Then there are other kinds of workings which form an intermediate link between placer mining and quartz mining, such as drift mining, under barren gravel or lava cap, cement mining, pocket mining, sluicing of decomposed vein-croppings, etc. Some of these cost less, others more, than regular vein-mining. The experience as to cost is of little value, for the conditions are too irregular and uncertain. Finally we come to those vein-mines which are worked by open cut, as were some of the great gold mines of the Black Hills district of South Dakota and elsewhere.

PERHAPS the best example of a great low-grade gold mine is furnished by the Treadwell, in Alaska, where very careful accounts are kept. In this case there are the disadvantages of remoteness and climate; otherwise the circumstances are peculiarly favorable. Allusion has been made already in this Department to the low costs at this mine, but it may be interesting to quote further details:

The Treadwell is practically an open quarry. The report of the Alaska-Treadwell Company for the year ending May 1, 1893, shows that the quantity of ore crushed was 237,235 tons, yielding an average of $2.13 in free gold. There were 4276 tons of sulphurets saved by concentration and 4584 tons treated, giving an average of $41.28 per ton. The average for all the ore treated, including yield from sulphurets, was $2.94 per ton. The cost of work last year is given very fully in the report. Mining (237,235 tons) cost for labor, 39.60 cents; supplies, 20.74 cents; total, 60.34 cents per ton. Milling (237,235 tons) cost for labor, 18.37 cents; supplies, 25.60 cents; total, 43.97 cents per ton. Chlorinating concentrates (4584 tons) cost for labor, $5.3432; supplies, $3.649; total, $8.9922 per ton. Averaging all costs on the ore mined, the result was: Mining, $0.60; milling and concentrating, $0.44; chlorination, $0.17; general expenses at mine, $0.07; San Francisco office, $0.02; bullion charges (freight, insurance, etc.), $0.05; total, $1.35 per ton.

LOW as the foregoing figures go, they do not yet reach the phenomenal record made by the Spanish mine, Nevada county, California, four or five years ago. The following description is taken from the *Mining and Scientific Press*, of San Francisco:

At this mine the vein averages ninety feet. The hanging wall is a slate, soft, shaly, and not well defined. The true vein is on the footwall and consists of solid quartz, four feet thick. It does not pay for working. The pay is found on the hanging wall side, which contains many veinlets and streaks of ferruginous quartz carrying gold. Where no quartz is to be found there is no pay. The slate on this, the west, side is talcose. The main tunnel was in 1200 feet. The vertical distance from the surface to the end of the main tunnel was 350 feet.

By connecting the tunnel with a surface excavation, the ore was run out through the tunnel in cars by gravity, the empty cars being brought back by mules. The material treated, being soft, was passed through roller mills. In a twenty-eight days' run, during which 3443 tons were handled and $3138.55 extracted, the cost of mining was $0.346 per ton; of milling, and other expenses, $0.239 per ton; total, $0.585 per ton. The ore only yielded a trifle over ninety-one cents a ton, yet a profit of $0.32 per ton resulted, giving a percentage of profit of 35.8 per cent. of

the total yield. In other months the mine had made almost as low records. This case is especially noteworthy on account of the comparatively small scale of operations.

IT would be useless, even were this the place, to quote further examples of the economy reached in the gold industry. The foregoing are sufficiently striking to dispel any notion that close figuring does not obtain in mining. But, lest it might be imagined that gold-mining furnishes an exceptional instance of economy, it may be added that equally instructive figures could be adduced from other lines of mining, notably in the mining of coal, iron ore, and copper ore. It is worth remembering that valuable metals are obtained, and profitably, from material handled at a cost often far below that of moving building sand, road gravel, or the cheapest and bulkiest substances worth handling at all. Mining is also often done more cheaply than the grading of roads and streets, excavating for sewers and pipes in cities, making railway cuts and tunnels, building jetties, or any other of the analogous operations carried on in thickly-settled communities. Another lesson to be drawn from the two cases of the Treadwell and the Spanish records just quoted is that the economy gained is equally as much in the metallurgical treatment as in the mining proper. This, too, holds with the making of coke and the extraction of metallic iron and copper, and indeed all along the line of metallurgical processes. But, in brief, the two main conclusions to be kept in mind are: (1) It is not safe to base estimates on phenomenal records, and (2) on the other hand it is all nonsense for the "process men" to claim that they are going to revolutionize present matters in a hurry.

WHILE on the subject of mine and reduction-works records it is proper to call attention to the method in which the accounts are kept and the averages derived. There is a great discrepancy between the systems followed at different establishments of the same class, so that comparisons become difficult. It is a matter of some uncertainty under which head a given item is to be charged, so when a company operates not only a mine but also a mill or smelter, or perhaps a number of separate plants all coming under the head of one establishment, or if separated still under one corporation, it makes considerable difference whether certain items (like haulage between mine and mill, for instance) are charged to one department or another, and how the general expenses are to be distributed. When a report is given in minute detail, as a few of our superintendents and secretaries take pride in doing, these items can be redistributed for comparative study. Unfortunately, the majority of company reports are published in such shape that they are almost unintelligible, and if they give the main things—that is, the true profit and loss for the year, condition and prospects of the property, etc.,—they may satisfy the average shareholder, but they are worthless from the technical standpoint. Indeed it is not so easy to learn from many reports even what the real commercial results are, any more than it is to understand the too commonly mystifying reports of banks, railways or insurance companies. The great fault, however, with most mining reports is in the numerous sins of omission. They do not allow for interest on invested capital and depreciation of plant, or set aside a sinking fund to extinguish investment. These matters should appear in the general financial statement. The general expenses, as office, commissions, freights, insurance, etc., form a group of items which certainly ought to be taken into account when figuring up the average cost per unit of product, though this is seldom done. Superintendents naturally like to make the best showing for the technical administration, and it is always a temptation to omit on this side every charge possible. For instance, taking the case of short runs or campaigns, it is a common thing to avoid charging up wear and tear, replacements of parts of machinery, and use of supplies already on hand. This practice may give an exceptionally good showing for a short period, but has to be made up in the end. An opposite

case often occurs in the statements for metallurgical works, when a total clean-up has not been made. The points here mentioned are only a few of the perplexities surrounding the question of mine accounts. There is room for a big book on the subject. It is well that some of the technical schools are taking the matter up, and provide some instruction in this line.

AN institution which has undoubtedly done much good, and which, within its proper sphere and under evident limitations, is to be highly commended, is a "correspondence school of mines" established in Pennsylvania by the enterprise and in connection with the management of an excellent technical journal, the *Colliery Engineer* (Scranton). The purpose of this school is to furnish a mining education—that is, so far as this can be imparted through books, essays, questions, and written examinations—to students at their own homes, at low cost and without the necessity of withdrawing their efforts and time from paid work, if they are engaged in any. It therefore fills a "long-felt want," in offering to working miners and young students some of the advantages of the regular scientific schools which they would otherwise be unable to enjoy. In its own field, then, it has been doing good work; and the writer, fully appreciating its merits, has had frequent occasion to recommend it to numerous inquirers who have applied for information in regard to means of getting a moderate technical education and who seemed unable to devote the time and money necessary in pursuing a full course at any of the regular institutions. It is with surprise, therefore, that this otherwise meritorious institution is found issuing the following advertisement:

MINING and Prospecting Taught by Mail, also Mechanical Drawing, Mechanics, Arithmetic, etc. To begin, students only need know how to read and write. Diplomas awarded. Low prices. * * *

Now, mechanics and arithmetic can certainly be taught "by mail" or by the study of selected text-books. So also can a number of other branches which might be enumerated. But it is assuming altogether too much to claim that "mining" (taking the word in a broad sense and as it is usually understood) can be taught by mail, by essays, lectures, or books. All that the best-manned and best-equipped schools can do is to give the student some idea of the general principles underlying methods of opening and working mines, and they generally try to supplement this sort of information by visits to mines and works where the things talked about are actually done—in short, by summer schools temporarily established in mining districts. It is quite possible to explain in a book why a shaft should be sunk in the hanging-wall side of a vein, why an adit would be preferable to a shaft under certain conditions of topography, why overhead stoping is better than underhand, why the long-wall method is better in some places than pillar-and-stall, why one style of timbering should be chosen rather than another, the quantity, pressure and velocity of air theoretically required in a given working, and so on. The young man who has been well grounded in these and similar fundamental propositions has an undeniable advantage at the outset over one who has not, but if he were turned loose to run a big mine without experience and with no further guide than his books, he would very soon find himself at a loss and, if wise, would fall back on the advice of his foreman. Fortunately the responsibility of managing a mine is not now often placed upon the shoulders of the young graduate of any kind of school. This of course applies more or less to all mining schools. The point is that if real mining cannot be taught by the best-equipped schools, still less can it be taught without their advantages.

PROSPECTING is another thing that is to be taught by correspondence. This is a serio-comic proposition, and only the innocent naïveté of the idea shields it from censure. Without knowing exactly how this accomplishment is to be imparted, it may be assumed to be on the lines laid down in the books. For instance, the hopeful prospector in search of metalliferous deposits starts out with the pre-

scribed equipment of geological hammer, note-book, lens, sample-bags, pick, shovel, and pan,—all of which he couldn't comfortably carry a mile on level ground. He begins at the mouth of a gulch and follows the drainage line upward. He picks up all promising or unusual pebbles, cracks open the quartz boulders, pans out the sands, and generally looks for float or colors. These of course he finds—in the books. Then he keeps on upward till his "indications" give out. At this point he knows that his lode, or whatever it may be, must be to the right or left of him, or at the head of the gulch if he is at the end of it. So he climbs up first one side and then the other of the cañon he is prospecting, looking for float until it ceases, then for croppings, or if there are none, he begins a series of trenches to uncover a blind vein. Ultimately he finds it—according to the books. Next he proceeds to locate and develop his discovery, as instructed. All this is plain sailing—or would be if things turned out as they ought to. But in real existence they do not. The amateur prospector would find himself about as helpless as the amateur geologist undertaking field work for the first time, and expecting to find actual sections marked off in nature just like the diagrams of the text-books.

To prospect successfully requires either that rough practical experience and intuition possessed by real prospectors, or a part of this supplemented by a thorough mineralogical training, or (as often happens) sheer blind luck. Most decidedly it is not to be learned by "correspondence." And speaking of mineralogy, how is one to learn to identify minerals without access to systematic collections and without a course in blow-piping? To know by rote the crystallographic form, specific gravity, hardness, cleavage, luster, color, fusibility, etc., of minerals is of little avail without practice, and pretty extensive practice at that,—certainly not without seeing and handling the things in question. The determination of ore minerals and substances of economic value may be self-taught (with disadvantages), if the proper books and material are accessible. So might the fire-assay, the wet qualitative tests, the wet quantitative assay, and colorimetric and volumetric assays, provided one had a suitable laboratory at hand. So too might surveying be taught, if one had the instruments and tables. And so also mechanical drawing and many other things. But all of these can be more rapidly and accurately acquired by being shown than by reading about them.

When it comes to metallurgy the correspondence system will find itself in a worse plight than ever. Suppose it is a question of concentrating a given ore or of adjusting a given type of machine. The books are full of researches in the higher mathematics bearing upon points of this sort, all of which are useful to the mechanical and metallurgical engineer who desires to perfect himself in his profession, but they would be of about as much assistance to the young aspirant to metallurgic honors and responsibility as a course in thermodynamics would be to a locomotive fireman. When brought face to face with practical problems, such as occur in actual work, he who relies upon what is called "book knowledge" alone, whether acquired through a correspondence school or at any regular technical institution, will discover to his sorrow that there is still a good deal more to find out.

Now, to return to our advertisement, which declares that "mining and prospecting" can be taught "by mail," and that only a knowledge of how to read and write is needed to begin with. It is something like going after reed-birds with a Gatling gun, perhaps, to be captious about the wording of an advertisement and to find fault with an admittedly meritorious undertaking merely because of a slip. But there is a serious side to the matter. While every mining man will pass over with a smile the assumption that mining and prospecting can be taught by mail (or indeed in any school), such a claim is likely to mislead some, and, though it may bring in a few more fees, it will not in the long run redound to the credit of this original and otherwise commendable scheme.

MACHINE SHOP PRACTICE

Conducted by Albert D. Pentz.

THERE should be in every city a local society or club of mechanical engineers who get together periodically and discuss professional questions. It will be observed that I do not say that they shall get together for the purpose of discussing mechanical questions, but that they shall actually discuss them. The trouble with mechanical clubs generally is that the right kind of men do not discuss the right kind of questions; in fact, they are not thought of, neither the right men nor the right questions. Ordinarily the questions most discussed in societies managed by professional men are those pertaining to the data and the mathematics of arts already established on a firm basis. Now, while I have no disposition to detract from the value of the formulation of data of assistance to any art, such formulation is of more direct interest to the teachers and pupils of schools than to those who are experimenting with and developing other arts yet in incipiency. The cry for help comes not from strong and healthy arts that already are conquering the earth, but from those now in the travail of invention. Instruction in mechanical movements is what is wanted. I do not mean the mass of kinematics theoretically taught in course of ordinary training, but specific instruction by men who know of their own experience which is the most appropriate motion with which to operate a particular new element in a new art. In some cases it is doubtful to the inexperienced whether a particular thrust should be performed by a lever, a screw, or a rod driven by an eccentric. There are men, however, who have had experience in arts analogous to every new art or in movements similar to every new movement, and these men will have discovered which kind of movement is best in that particular place. Hence, in each city, if all the engineers who do creative work should meet and discuss their actual needs, asking and giving in the spirit of progress, it is certain that interest in such meetings would be general and that he who gave would be as much benefited as he who received. Again, it is very improbable that any one can always be either the giver or the receiver.

A GREAT fault to be found in some societies is that in each a coterie representing a small but influential faction obtains control of the management and rules the society. In such cases many vital questions with which such a coterie may not be in sympathy will be pigeon-holed, though there be papers of great value to such questions offered for their discussion. On the other hand, to subjects congenial to the coterie, and to papers presented by those *in persona grata*, there is an enthusiastic and effusive welcome offered, though perhaps such papers may treat of nothing new under the sun. When this fault exists, it is incurable, except at the cost of cutting away the predominating faction; it grows stronger on abuses. No criticism can be offered that does not entail a punishment out of all proportion to its importance. Neither can members who offend by offering criticism ever hope for distinction within these societies. Personal ambition, if permitted to take root and grow within a society, will ruin that society by absorbing its vitality. And it will ruin the society, or try to, if it be removed.

DURING an afternoon spent with that fine engineer, C. W. Hunt, he told two stories illustrative of as many vital points in machine design. The first was of grand old John Fritz, to show how slow and tortuous is the road to perfect

operation in a new device. A friend of John Fritz, also an engineer, asked him if all or any of his grand improvements worked at once as originally designed. John Fritz's answer was: "When we get the idea of a device which we think will work, we call a council of all those who can assist or who are to carry on the work, and we talk it over. Then we have rough sketches of it made, and we talk it over again. Then we have working drawings made and we talk it over again. Then these drawings are taken into the shop and the device is made. Then when it is finished, the boys come and ask me to go and look at it. Then I ask them if it is all made like the drawings, and they will probably say it is. Then I ask them if it works properly, and perhaps they will say 'yes.' And then I will tell them, 'Now we will go down into the shop and see why it doesn't work.'"

THE other story is of an engineer who operated from data only, and who built a bridge with a long span, getting his every element from theoretical sources. The very first freight-train that crossed that bridge went down, taking the bridge with it. The engineer could not believe that his bridge had collapsed, as he had calculated with great care every strain it could receive. So he went out to see if the fault did not lie in material or workmanship. Neither of these, however, showed a defect, so he retired to his closet and went again over his calculations. It was toward the middle of the second afternoon when he emerged from his researches, and as he passed out into the open air one of his assistants heard him mutter:

"Damn that decimal point."

What that engineer needed was the trained eye of practical experience that usually is able to see whether a section, an arch, or a lever is strong enough. An experienced man should be the complement of the mathematician in every calculation of any consequence. Where but one engineer is to be employed, select the practical man, or better, one who is both the one and the other.

THE most economical cross-section for resisting torsion is, of course, the hollow cylinder. But an economical lever that receives no torsional strain, and delivers none, should have a cross-section that may be described as an ellipsoid. I get this section thus: After the length of the section and its width are determined, I draw a circular arc that has a chord 10 per cent. longer than the major axis of the desired section, with a versed sine equal to just half its minor axis. Then, with another small circular arc joining the larger arc to the length to which the section is limited, the thin edge of the section is completed. Where the strain is only on the plane occupied by the major axis of this section, and where this major axis is a plane at right angle to the fulcrum of the lever, this seems to be a most satisfactory form. Where the strain in a lever is both torsional and flexional, the section ought to be an ellipse, hollow if practicable with the major axis arranged to oppose the greater strain.

CUTTING-TOOLS on metals do not always wear to the extent they are supposed to wear. Ordinarily they are burned by too great a speed. It may not be amiss here to explain what this burn is. When two pieces of similar metal are moved, the one upon the other, while held together with considerable pressure and without a lubricant, they soon will weld together at the point undergoing the greatest strain and friction. Thus, an iron shaft in an iron box becomes cut or galled, and thus the point of a steel tool when cutting iron is often taken away after doing but little work. Dissimilar metals do not burn each other to so great an extent. When an iron shaft is contained in a box of bronze, one metal being no harder than the other, they seldom or never unite; therefore a steel tool can cut brass or hard bronze at very high speeds. In planing cast-steel it is questionable whether a speed above twelve feet per minute is safe, but in cast-iron, where graphite is present in the iron, it lubricates the tool and sometimes it is safe to cut twenty feet each minute through the material.

IN the interval after one discoverer of perpetual motion is silenced, and before another asserts himself, the inventors of processes and means to harden copper have their innings. I think it was Wendell Phillips who, in his lecture on Lost Arts, asserted that copper could be hardened and made to cut like steel, and that it had been found so hardened in the ruins of Egypt and ancient Mexico. Possibly this is so, but Humboldt found that a Mexican specimen of hard copper was composed of .94 copper and .06 tin. Wilkinson also found about the same proportion in an Egyptian sample, with the addition of a trace of iron. Now tin always makes copper harder and there is no evidence of other means to harden it, and I do not believe that a piece of pure copper can be made as hard as steel is made by any process, new or ancient. I will gladly pay a good price for a very small specimen of pure copper made so hard that it can cut iron as steel does without melting the copper to harden it.

WE have a rope-drive working under the following conditions: Rope about 1000 feet long, 1⅛ inches thick, furnishing about 50 horse-power to six floors, one above another. This rope runs on about thirty sheaves, thirty-six inches in diameter, and part of the way the rope is exposed to the weather. The first rope was used up in five months. It was dressed once in two weeks with a compound of tallow and graphite. It broke three times before it was discarded, and at each break a new piece of rope was inserted. The present rope has been used about five months. It is a much looser spun rope, composed of but three strands. The other had four strands and a core. This rope is and has been treated every two weeks to about two quarts of boiled linseed-oil, dripped one drop at a time upon one of the sheaves which is uncovered on top, taking perhaps three days to drip it on. The rope covers the bottom of the sheave and absorbs the oil. If oil be administered too fast, it will be thrown off and wasted. It now shows but little wear on the outside and none within. It is as firm as oak, yet sufficiently flexible and reminds me of hard sole-leather. The rope travels at least 1800 feet per minute when at work.

ORDINARY dough is often used by die-makers to remove filings and other kinds of dust from cavities that are being operated in. This substance could be used advantageously in many places by makers of fine tools. If the dough is of the proper consistency, it will hold together strongly and work well for days. The dirt it absorbs does not impair its efficiency and it is only rendered useless by becoming hard or sour. If the subject were studied, I presume that some liquid besides water—perhaps glycerin—might be found to keep the dough soft and prevent its turning sour.

A substance called "corn-pith" is also used in watch-factories for about the same purpose as that indicated for dough. I presume from the name that it is the inner part of the stalk of maize. The pith of elder, I think, would serve the same purpose.

IN a factory the man who works for a personal record is a hindrance. Suppose that he is running an engine, and that he is trying to make a phenomenal record for economical results; he wants to produce more horse-power with less coal. He tunes up his engine and studies his fires so carefully that he succeeds about four hours out of five. But in the other hour, when the polishing-room is pushing its work, the circular saws are running, and the elevators are lifting heavy loads, the engine will slow up about 10 per cent. Thus while the coal-pile is saved to the extent of perhaps fifty cents, the factory suffers a loss of fifty dollars.

CATALOGUES may be indexed in this manner: When one arrives it either is numbered at once by having the next higher number pasted to it, or it is put with others, until a month's receipts are in, and then all are numbered together and placed in drawers holding twenty-five or more. These drawers also are numbered. When a drawer is full—or perhaps upon the re-

ceipt of each catalogue—they are searched through carefully and every subject in every catalogue is noted on a separate card. Thus we have perhaps one hundred cards headed "Engine Lathes," each referring to a different catalogue and specifying that catalogue by drawer and number. When a catalogue is received from a concern whose previous editions are in hand, it goes in just the same and takes the next higher number. The older ones, however, remain in the drawers and their cards remain in the index case. This permits us to trace obsolete articles, and to follow changes. One prominent concern changes all the numbers on its milling machines and we thus can tell what was the old number of a present new number. These cards are kept in card-cases such as are used for cataloguing libraries. It takes not more than five minutes to find any subject and all there is about it in every catalogue in the office. Separate cards may be written for each catalogue and kept in a separate compartment as "addresses."

The data also,—for modern catalogues contain a great deal of valuable scientific data,—are indexed in the same manner. To this may be added current technical literature, indexing the really valuable articles by this same convenient system.

FOUNDRY-MEN are really behind the times, for if machine-shop people were to offer work as inferior as that of many molders, American mechanical superiority would no longer exist. That two castings from the same pattern, made by the same man, should vary in weight 10 per cent., is a mechanical crime that should be punishable. It would be punishable if there were enough foundries in existence where castings are made "true to pattern," and the punishment would be entire loss of trade.

I AM obliged to differ with Professor Torrey, who wrote in the Magazine last month on mechanical instruction in technical schools. I admit that many graduates of technical schools "aspire to positions of responsibility and trust in manufacturing establishments." I admit further that frequently they attain these positions. But do they fill them? Can any man direct the work of manufacturing efficiently who does not know how to direct the operations in detail? As well might we expect a yachtsman to become expert by viewing races from an excursion steamer. We do not need to discuss this question in theory: We all know how it actually operates in practice,—that until the graduate gets real practice on actual commercial work, he has no value in mechanical positions involving trust or responsibility. Clerical positions, on the other hand, can be filled easily by persons having no technical education whatever.

IN experimenting on new devices it often happens that a very elaborate or a very crooked piece of metal is required. If such a piece were to be forged, the cost would be frightful. If it should be cut out of the solid stock, the expense would be greater still. The cost of a regular pattern could not be thought of; besides, such things generally are of such shape that they cannot be drawn from the sand in a two-part flask, and they frequently have to be cored in the most unpractical places. When such pieces are required in my own work, I sometimes make them of wax. Any kind of wax that will hold together and melt at a low temperature will do. I place the cores, having suitable extending supports, in position where they are needed, and hold them there temporarily on wires, which wires are to be withdrawn from the mold before the piece is cast. Then the shape which is needed is modeled about the cores by hand from the wax made plastic by warmth. When the desired shape is finished it is molded, with no partings, in a single flask. It must have the usual gates and vents, however, so that when the mold is heated in a core-oven, the wax will run out into a pan. Usually after such a mold is heated it is best to turn it over to empty any pockets there may be in them of the wax, so that it may find its way out through the vents. One skilled in such matters can make a pattern such as this much quicker than he can

make a drawing of it. Of course this process destroys the pattern, which in machine-manufacture is often an undesirable contingency. In art castings, however, as in the French statuettes, it is desirable that one shall not be exactly the copy of another. So this method with certainty secures the result that each is itself a work of art, and unlike any other in existence. I have seen Japanese workmen "sweep" the core for a bell to weigh two hundred pounds or more, then sweep wax on that core to make the shell of the bell of the thickness desired. On this wax the designs and ornaments were engraved, all with the simplest tools, a few pieces of wood, and a graver. Then the whole is covered with loam. After that the wax is melted out, saved, and a casting made which always is a work of fine art.

I HAVE a friend who, some time ago, experimented in incandescent electric lamps and became quite an expert glass-blower. Now when he wants to make patterns for castings, he takes a tube of glass and blows it into the desired shape, and it must be a complicated contrivance which will not submit to his fashioning.

THERE really is no good chuck made for drills used in drill presses. They are all unreliable after a short usage and the unreliability is generally in the element which grips the drill tightly and makes it run true. One kind wears out of truth on the shoulder which locates the jaw-screws. Another wears out on a worm and gear. In another the angular sides and edges soon lose the centering precision, if it ever has it, and so on. It seems to me that some one should be able to devise a strong and durable self-centering drill-chuck, or so improve one of those now made that it shall be satisfactory for one year at least.

JUST how far a belt dressing is good and how far it is bad, is an unsettled question. A certain quantity of a suitable oil preserves leather. Too much will destroy it. I do not think that, on the whole, oils improve the tractive power of a belt. If they do it, it is at the expense of the motive power at its source. As a filling to preserve the leather, degras is probably the better of many, but neat's-foot oil is good, so also is castor-oil.

IT seems almost too late to advocate the placing of friction clutches on the main lines of shafting in every factory. But when so few are found that have these conveniences, the necessity is apparent. Do not all shop-owners know that a few short stoppages of the engine cost more than a whole suit of clutches? Suppose, for instance, that in a factory employing one thousand hands to operate machines an accident occurs. Perhaps a belt catches on the main shaft and wraps, so that it requires a stoppage of fifteen minutes to get it off. At an average of twenty cents per hour per operative, this stop costs fifty dollars. But in a shop where friction clutches are prevalent, there need be but fifty men idle, at a cost of two dollars and a half.

A FEW years ago, having to use lard-oil for lubricating purposes, and finding it to gum on cast-iron surfaces so much as to be detrimental, and imagining that the gumming quality in the oil was gelatine, I filtered a quantity of it through tannic acid. This certainly improved it, but was expensive. Now lard-oil is without doubt one of the best lubricating oils known, but it will get gummy with the conditions above named, and I have looked for many years for a means to rid it of its sole evil element. Recently, having occasion to experiment with an oil-filter, I noticed that one of the printed directions is aimed toward the fact that too much heat in the water with which this filter is charged will coagulate lard-oils. I find this to be a fact and, further, that the coagulated particles will precipitate, and after a few days be found at the bottom of the oil. The oil then can be poured off, and it seems to have parted with its gummy quality. If others will try this, and if they find the same result, an improved lard-oil is possible, and the improvement will be a cheap one in respect to first cost.

CURRENT TECHNICAL LITERATURE

THE THEORY AND PRACTICE OF MODERN FRAMED Structures. Designed for the use of schools and for engineers in professional practice. By J. B. Johnson, C. E., Professor of civil engineering, Washington University, C. W. Bryan, C. E., and F. E. Turneaure, C. E., Professor of bridge and Hydraulic engineering, University of Wisconsin. New York: Wiley & Sons. [Cloth. 4to. 508 p. $10.]

SINCE the time of Professor Rankin, the scheme of text-book preparation has undergone a great change. Many writers, while not agreeing with the world-renowned preface of Mr. John C. Trautwein, that the works of many of the great writers are "little more than striking instances of how completely the most simple facts may be buried among heaps of mathematical rubbish," still believe that purely theoretical demonstrations of many of the truths that we use in daily life should be relegated to special books, and this is a case in point. The authors state in their preface, "this work is something of a compendium, a text-book, and a designer's handbook, all in one." We must therefore judge the value of the work not only by its filling a place, but also by the success with which the writers have attained their avowed object.

The book is divided into two parts, with an appendix, the different chapters being prepared by different authors, the intention evidently being to have each writer treat the matter with which he is most familiar in order to obtain the best results. As a whole, the book may be said to be a decided success, not alone for what it is, but also for what it indicates, and especially because it shows a recognition on the part of the instructors of the necessity of equipping the student with practical knowledge at the very outset. In addition, the treatment throughout is happy and explicit. The information given is as nearly as possible up to date, and it is therefore a work which should be found in every engineer's library. Some of us may feel that the analytical method is given too much importance as compared with the graphical, but that is a matter of detail. We may also feel that it would have been better to have made two volumes, with a more distinctive separation between the text-book and the handbook, and that quite a considerable portion of the work could with advantage have been furnished to the student in the form of lectures, but these too are details.

The chapter scheme is as follows: Part I.—(1) Definitions and historical development; (2) application of the laws of equilibrium to framed structures; (3) analysis of roof-trusses; (4) bridge-trusses—analysis for uniform loads; (5) bridge-trusses—analysis for wheel loads; (6) conventional methods for treating loads; (7) lateral truss systems; (8) fundamental relations in the theory of beams; (9) column formulæ; (10) combined direct and bending stresses; (11) suspension bridges; (12) swinging bridges; (13) cantilevers; (14) metal arches; (15) deflection. Part II.—(16) Determining conditions of the styles of structures; (17) design of individual members; (18) details of construction; (19) plate girders; (20) roof-trusses; (21) railway bridges; (22) highway bridges; (23) detail of Howe truss-bridge; (24) detail of swinging bridges; (25) trestles; (26) esthetic design; (27) stand-pipes; (28) iron and steel tall building construction; (29) Iron and steel mill-building construction.

Every chapter is good, showing the results of earnest thought and hard work, still in places it would seem as though an improvement could be made; thus it is questionable whether, in making the stress diagrams, it would not have been better to have marked the lines *plus* and *minus* rather than to attempt to indicate the character of the stress by the weight of the line, since in draughting it is easier to

write a sign than to draw a line over two or three times to make it wide enough; and especially so when an exceedingly sharp pencil is used in order to make the closures as accurate as possible.

Chapter VIII should have been nearer the front of the book. The subject matter is excellent, and the tables showing the relation between M, I, and R, are good; but it seems rather a pity that graphical methods of determining M for a variety of loads, are not given. Chapter IX does not go so far perhaps as it might into a discussion of the relations between the various members. Chapter XIII is good, although the maximum and minimum proportions have not been indicated and might have been with advantage.

Chapter XIV contains a certain amount of mental gymnastics evolved in connection with the arch fixed at the springing lines which might as well be omitted, since it is highly probable that no one would ever build an arch with fixed ends. It would have been well, since beams and girders have been treated, to have discussed their deflections. The fact that the principles are the same, and that the result can be taken out by careful study, is perhaps the reason it was not done. The table given on page 224 is very excellent. The results of tests of rivetting, given on pages 263–265 are very good. The conventional rivetting signs given on page 267 are substantially those originally devised by Mr. Frank C. Osborn, M. Am. Soc. C. E., and although extensively adopted by the bridge-builders throughout the country, should be credited to him in a standard work.

In either Chapter VIII, or the preceding one, attention should have been called in the designing of compressions members at the end pins, to the necessity of transferring the strains over the member more fully, as was very excellently brought out in a paper by Mr. Thomas H. Johnson presented before the Engineers' Society of Western Pennsylvania, reported in the *Engineering Record* for June 17, 1893.

The treatment of roof-trusses inclines toward that of large roofs, and it would have been well for the writer to have noted the fact that it is very desirable in small roof-trusses to proportion the purlins or upper members so that at least two men could have been carried on their center without injurious deflection so as to make it possible to paint the truss and its covering without erecting a scaffold for the purpose. The treatment of the purlins and the loss in strength of section due to the inclination of the purlin might also have been noted.

Chapter XXVIII is not only very good, but very much needed on account of the tendency at present to use cast-iron columns in building construction. It is well to remark, however, that office buildings, to which this chapter most generally applies, are, by reason of their character, subject to well defined laws which quite closely limit the general details of design, and it would have added much to the value of the work and to the meager literature on the subject, to have had a discussion as to the limiting conditions of height as compared with breadth, the deflection of skeleton construction under wind pressures, the proper amount of wind pressure to provide for, and the most economical spacing of beams, girders and columns. In the examples given, no weight is given to the column spacing. Mention should also have been made in the designing of floor-beams of the fact that, in order to keep the deflection within safe limits, it is desirable to have the depth of the beam one-twentieth of the span.

The method of calculating, as given, seems to be rather putting the cart before the horse; less work would be required and better results obtained if the loads were traced from the floor blocks to the beams, then to the girders, and from the girders to the columns, increasing the safe fiber strains in a regular ratio up to the columns and decreasing the load at the columns in a regular ratio. We know that it is quite likely that the floors will be loaded in isolated cases to 500 pounds per square foot, that an office might easily have 100 pounds per square foot of live load in it, while the average throughout the building would probably be about 25 pounds, and by taking ½ to ⅔ of the girder reactions

for the column loads, we should approach very closely to exact conditions and would know exactly the amount of eccentric loading to which the column was subjected.

The foundation methods explained, while excellent, and a decided advance on the first of Chicago steel cribs, are still wasteful in their use of metal, and it would have been well to have called attention to the use of girders for spreading members. In figuring the areas required to carry the loads sufficient experience has not yet been gained to state positively that no live loads should be allowed for, and it would have been well to have left this open. Lack of more detail treatment of these points is probably due to the limitations imposed by the scope of the work, since Mr. Purdy has done most excellent work in this line, and the above points would naturally suggest themselves to him as requiring it.

The closing chapters and appendices are most excellent and will be of much value, and the work as a whole marks a decided advance in technical literature, and is to be much commended, such points as are noted being really of trifling weight as compared with the whole.

GEORGE HILL.

LECTURES ON SANITARY LAW. By A. WYNTER BLYTH, M. R. C. S., L. S. A., Fellow of the Institute of Chemistry; Barrister-at-Law of Lincoln's Inn; Professor of Hygiene, College of State Medicine. London and New York: Macmillan & Co. 1893. [Cloth, 8vo. 287 p. 8*s.* 6*d.*, net.]

ONE of the earliest subjects of legislation, even in the rude beginnings of civilization, was the preservation of public health. As science developed, it was demonstrated that many of the ancient ordinances had a solid basis of reason. In modern times, England, France, Germany, and the United States have done much by legislative enactment to promote true methods of sanitation, and each of these countries has a large and increasing literature upon all that pertains to sanitation. Periodicals devoted to sanitation and to sanitary engineering, with a constantly growing influence, have taken a permanent place among modern technical publications. Schools of technology have found it necessary to afford facilities for instruction in sanitary science as a special branch of study. The results of all this are apparent. For example, during two successive summers Asiatic cholera has threatened to invade the United States, yet, through a more adequate knowledge of its character and causes than was possessed in former epidemics of this dreadful disease, the energy and watchfulness of able health officers have been successful in preventing its gaining a foothold.

Fifty years ago Americans were horrified by the picture of the frightfully unsanitary condition of the tenements of the poorer classes in England, and of shops, factories, and mines in that country, as vividly portrayed in Lester's "Glory and Shame of England." Much has been done since that time by legislative enactment toward remedying the then existing evils. Sanitary laws have multiplied, and nearly everything essential to public health has been made the subject of scrutiny by able commissions with a view to intelligent legislation for the abatement of public nuisances, the prevention of excessive labor exactions, the proper ventilation of mines and factories, limitations of age of children with reference to their employment in certain kinds of labor, and the protection of rivers from pollution by the discharge of noxious and offensive matters into their waters.

The extent and scope of sanitary legislation in England will be surprising to many people who will peruse with interest the excellent book before us. It comprises twelve lectures on sanitary law delivered by Professor Blyth as part of a regular course of instruction in sanitary science in the College of State Medicine in England. The first lecture is devoted to a description of the administrative sanitary districts and sanitary authorities, urban and rural, in England, Wales, Scotland, and Ireland, with legal definitions of what constitutes an owner, a house, a building, a drain, a sewer, a canal, and a canal-boat. The second lecture deals with the subject of nuisances, which are divided into "common," "private," and "mixed" as statutory nuisances under the Public Health acts; with references to

leading cases that have been decided in the courts where abatement of nuisances has been sought by legal processes. An interesting feature of this lecture is its able discussion of nuisances arising from accumulations of unsanitary or offensive matters, overcrowding in dwellings and factories, uncleanliness and imperfect ventilation in factories and workshops, smoke, and the neglect to properly fence in abandoned shafts of coal-mines, or otherwise to provide that they shall be rendered safe against possible injury to life and limb. The subjects of sewerage, drainage, and water-supply form the subject matter of the third and fourth lectures. The fifth, sixth, and seventh lectures relate to sanitary appliances, regulations, by-laws, and statutory provisions with regard to the prevention of disease. The eighth, ninth, and tenth lectures respectively treat of port sanitary law, the "Housing of the Working-Classes act" (1890), and sanitary law as it relates to canal-boats. Two lectures on Metropolitan sanitary law complete the course.

An appendix comprises specimens of by-laws in force in the metropolis as to certain offensive trades, as tripe-boiling. the knacker's trade, catgut-making, gut-scraping, the manufacture of glue and size, blood-drying, fat-melting, and the manufacture of animal charcoal. The appendix also contains proposed by-laws under the "Public Health (London) act," this act providing for the regulation of the sale of food, drugs, etc. The work is especially well indexed.

To those who wish to become familiar with English sanitary law the book will furnish in compressed form a very comprehensive view of it. To sanitary engineers the book is also recommended, especially to those who are liable to be called upon as expert witnesses in litigations relating to pollution of water-supply, and the effects of certain manufacturing industries upon the health of surrounding population, and also to municipal authorities as a guide to procedure in securing general sanitation of cities and towns, which are questions of moment.

LEICESTER ALLEN.

THE TRANSITION CURVE BY OFFSETS AND BY DEFLECTION ANGLES. By C. L. Crandall, C. E., Associate Professor Cornell University. New York: John Wiley & Sons. [Cloth. 16mo. 64 p. $1.50.]

WHILE this book is intended primarily for the use of civil engineering students, the author believes that the complete set of tables given by him will render the methods developed by him for the true transition curve at least as rapid and convenient in use in the field as the more restricted ones now in use.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE. Edited by Bennett H. Brough. Vol. XLIII. No. 1, 1893. London and New York. [Cloth. 8vo. 476 p.]

THIS volume is divided into two sections. The first contains the presidential address, which deals with some of the developments attained in the metallurgical operations of English iron and steel works, and papers "on the elimination of sulphur from iron," "the recording pyrometer," "puddling iron," the methods of determining chromium, etc. Each paper is followed by discussion. The second section comprises notes on the progress of the home and foreign iron and steel industries under the following sub-headings: iron ores, refractory materials, fuel, production of pig iron, production of malleable iron, forge and mill machinery, steel, physical properties, chemical properties, chemical analysis, and statistics.

THE LAW AND PRACTICE UNDER THE STATUTES CONCERNING BUSINESS CORPORATIONS in the State of New York. By Dwight Arven Jones, Editor of the New York Business Corporation Laws since 1884. New York: Baker, Voorhis & Co. 1893. [Sheep. 8vo. 351 p.]

THE value of this work to the business community is sufficiently indicated in the title. The author endeavors, not only to present the existing statute law of the State relating to business corporations, but also to show the connection between this law and the statutes that have preceded it, thus correcting the impression that the State has fallen into a vacillating policy with respect to corporations. The book includes the text of the business corporations law, the stock corporation law, the joint-stock association laws, the taxa-

tion laws, and many other important statutes. Thirty-eight forms are also given.

TABLES FOR THE COMPUTATION OF RAILWAY AND OTHER Earthwork. Computed by C. L. Crandall, C. E., Associate Professor of Civil Engineering, Cornell University. Second edition. New York: John Wiley & Sons. [Cloth. 8vo. 42 p. $1.50.]

THE object of these tables is to present a convenient aid in the computation of railway earthwork. The volume is first found by the approximate method of averaging end areas, to which can be added, if desired, a correction due to the strict prismoidal formula, or a correction due to a modification of it for irregular ground. To this edition has been added a proof of the prismoidal formula and a comparison with others in use, a formula for correction for curvature, and rules for cross sectioning.

THE INTERNATIONAL COLUMBIAN NAVAL RENDEZVOUS and Review of 1893 and Naval Maneuvers of 1892. Washington: Government Printing Office. [Paper. 8vo. 238 p.]

THIS is the twelfth annual publication of the General Information Series of the Office of Naval Intelligence. It meets the demand for an authentic and connected narrative of the rendezvous and review at Hampton Roads and New York. There are also notes on naval administration and personnel, ships and torpedo boats, ordnance, and small arms, indicating the progress of the different countries. A list of standard books on professional subjects is added.

ADDRESSES DELIVERED BEFORE THE WORLD'S RAILway Commerce Congress held in Chicago, Ill., June 19-23, 1893, under the Auspices of the World's Columbian Auxiliary of the Columbian Exposition. Chicago: The Railway Age. [Cloth. 8vo. 265 p.]

THE addresses collected in this volume constitute a remarkable body of fact and argument on the subject of transportation. It is not too much to say that they will be found of lasting value and interest. The addresses are grouped under four general heads: railway law and legislation, railway management and operation, railway employés, and railway history and development. There are thirty-two addresses in the volume, and no question of importance has been neglected by the speakers.

OUTLINES OF PRACTICAL HYGIENE ADAPTED TO AMERIcan Conditions. By C. Gilman Currier, M. D. New York: C. B. Treat. [Cloth. 8vo. 454 p. $2.75.]

THE preparation of this book, we are told in the preface, was undertaken at the instance of busy practitioners and students, who emphasized the need of a compendious work upon practical hygiene, embodying the most modern truths and adapted especially to our conditions. Two-thirds of the contents of the volume do not come within the scope of this department; but our readers are interested in that part which deals with water and water-supplies, sewers and the disposal of fluid waste, house drainage and plumbing, and the disposal of garbage and other solid refuse. A judicial attitude is maintained throughout, and no positive opinions are advanced except where there is a consensus of leading thinkers in favor of them.

NEW BOOKS OF THE MONTH.

Astor, W. Waldorf.=The Case for Gold. New York: G. Routledge & Sons. [8vo, 69 p., paper, 25 cts.]

Kemp, Ja. F.=The Ore Deposits of the United States. New York: The Scientific Publishing Co. [8vo, 317 p., cloth, $4.]

Knight, G. H.=Patent Office Manual, Including the Law and Practice of Cases Holding a Revisory Relation Thereto. Boston: Little, Brown & Co. [8vo, 655 p., sheep, $5.]

Lowell, Josephine Shaw.=Industrial Arbitration and Conciliation: Some Chapters from the Industrial History of the Past Thirty Years. New York: G. P. Putnam's Sons. [cloth, 12mo, 120 p., 75 cts.]

Meyer, Franz Sales.=Handbook of Ornament. A grammar of art, industrial and architectural designing in all its branches, for practical as well as theoretical use. New York: Hessling & Spielmeyer. [8vo, 580 p., il., cloth, $3.60.]

Oberholtzer, Ellis P.=Home Rule for Our American Cities. Philadelphia: American Academy of Political and Social Sciences. [Paper, 12mo, 165 p.]

Orndorff, W. R.=A Laboratory Manual. Containing directions for a course in organic chemistry systematically arranged to accompany Remsen "Organic chemistry." Boston: D. C. Heath & Co. [12mo, 40 cts.]

Osborne, G. P.=Principles of Economics. The satisfaction of human wants in so far as their satisfaction depends on material resources. Cincinnati: Robert Clarke & Co. [8vo, 450 p., cloth, $2.]

Pitcher, Ja.=Outlines of Surveying and Navigation. For public schools and private study; to which is appended Washington's farewell ad-

dress; with 100 questions by J. P. Syracuse. New York: C. W. Bardeen. [Cloth, 37 p., 16mo, 50 cts.]

Ralph, Julian.=Our Great West. A study of the present conditions and future possibilities of the new commonwealths and capitals of the United States. New York: Harper Brothers. [Cloth, 8vo, 486 p., $2.50.]

Tuckley, H.=Masses and Classes. A study of industrial conditions in England. Cincinnati, O.: Cranston & Curtis. [12mo, 179 p., cloth, 90 cts.]

United States, Department of the Interior.= U. S. Geological Survey. Eleventh annual report, 1889–90. by J. W. Powell. Washington: Government Printing Office. [Cloth, $3.]

Wheeler, Candace, Editor.=Household Art. Being a collection of essays on decorative and applied art, the development of homes, etc. New York: Harper. [16mo, 300 p., cloth, $1.]

Wright, Carroll D.=The Relation of Economic Conditions to the Causes of Crime. Philadelphia: American Academy of Political and Social Sciences. [8vo, 116 p., paper, 25 cts.]

NEW TRADE CATALOGUES.

Any of these catalogues free on application to the manufacturers.

The Pratt & Whitney Company, Hartford, Conn.=Descriptive and Illustrated Catalogue. 390 p. [Representing classes of tools and machines produced by the company. Bolt-cutting machines, bolt-pointing machines, boring-mill, drills, lathes, cutters, gages, dies, etc.]

The American Road Machine Company, Kennett Square, Pa.=Good Roads and How to Make them. 48 p. [Consisting of some practical information on methods of constructing, maintaining, and repairing of dirt and stone roads.]

The Campbell Printing Press and Manufacturing Company, New York.=The "Economic." 8 pages. [The latest and most improved two-revolution press; a continuous register rack.]

The Watson Perfect Combustion Heater Company, Toronto, Canada.=The Watson Perfect Combustion Heater. 8 p. [For heating by hot water circulation, steam, and hot air. Chemical and mechanical explanations of the process and apparatus.]

Baldwin Locomotive Works, Philadelphia, Pa. =Locomotives exhibited at the World's Columbian Exposition. 78 p. [Express passenger locomotive, compound express passenger, compound freight, heavy freight, tank switching, etc. The locomotives comprising this exhibit were for the most part built in the regular course of business.]

Thomas Carlin's Sons.=Machinery in Stock. 20 p. [Portable hoisting machines, portable and stationary engines, vertical boilers, steam pumps, heaters, etc.]

The Edward P. Allis Company, Milwaukee, Wis.=Duty Tests of Triple Expansion Pumping Engines. 60 p. [Description of plant and of the tests; the great economy shown by the engines.]

M. C. Bullock Manufacturing Company, Chicago, Ill =Willans' Patent Central Valve Engine. 24 p. [Describing the central valve high speed engine; retrospect, objections, direct coupling, search, found, economy, tests, etc.]

Massachusetts Institute of Technology, Boston.=A brief account of its foundation, character, and equipment. [Prepared in connection with the World's Columbian Exposition. Illustrated. 40 p.]

Charles Munson Belting Company, Chicago, Ill.=Pure Oak-Tanned Leather Belting. 91 p. [Practical hints concerning use of leather belts, rule for calculating lengths; tables on transmission of power, telegraphic code, price list, testimonials, etc.]

The National Machinery Company, Tiffin, Ohio.=[Bolt and nut machinery, upsetting, bending, spine, rivet, wire nail, and special machinery; also complete outfits for railroad, bolt, car, and locomotive shops.] 172 p.

J. W. Reno, E. M., New York.=A description of an underground electric system. 20 p. [Objections to the system of the Rapid Transit Commission, and description of the Reno system, consisting of a double-decked tunnel of 23x23 feet cross-section.]

The Bucyrus Steam Shovel and Dredge Company, South Milwaukee, Wis.=Catalogue Part 1.—Steam Shovels. Third edition. 44 p. [No. 0, crane pattern, No. 0, boom pattern, No. 1 crane pattern, No. 1 boom pattern, etc., specifications, land dredge.]

The Bucyrus Steam Shovel and Dredge Company, South Milwaukee, Wis.=Improved Processes of Placer Mining by the "Bucyrus" Patent Amalgamator. Second edition. 22 p. [Descriptive of a plant that can deal with large volumes of low-grade deposits and use a very small quantity of water.]

Keuffel & Esser Company, New York.=How to Select Drawing Instruments. 15 p. [Descriptive of the Paragon instruments, material and finish, and showing their superiority; compasses, drawing or ruling pens, spring bows.]

Objects of Interest to Engineers and Others in and about Philadelphia. Engineers' Club of Philadelphia. 110 p. [A copy of a list prepared by the Club for the use of visiting engineers. Objects especially worthy of notice are indicated by single, double, and triple stars.]